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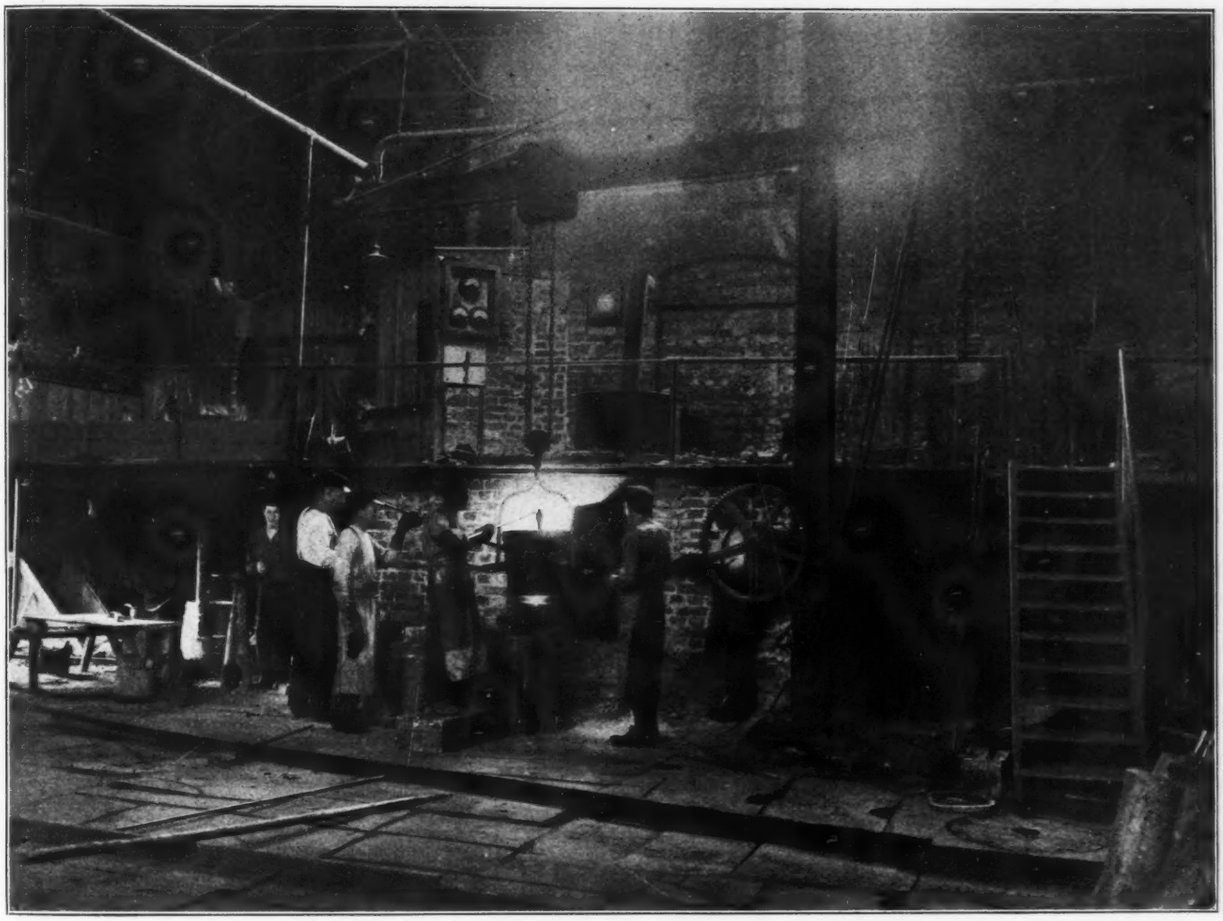
The Electric Furnace in the Production of Iron and Steel.

Within the past decade there has been great interest taken in the use of electricity in the production of iron and steel, not only in connection with its utilization for power distribution in the great steel works, but also for electro-magnetic concentration and even for electric smelting of the ores and the refining of the metal.

Electro-metallurgical plants will undoubtedly be installed in many countries where iron ore is abundant and where water powers are available, which may be utilized to take the place of coal, by the generation of electricity and the employment of the electric furnace. In South America, New Zealand, and other countries under similar circumstances imported iron and steel is extremely high in price, and when hydro-electric plants can be constructed, supplying a cheap and constant source of electric energy, the electric furnace can unquestionably be used to advantage.

It can hardly be claimed for the electro-metallurgic production of iron and steel that it can be carried on in competition with modern existing methods operating under the best conditions, since where coal is cheap, the ore is handled economically and the product is produced in vast quantities. The electric furnace can, however, in connection with the largest steel plants, produce an excellent quality of iron and steel for special purposes, requiring material of a high degree of purity.

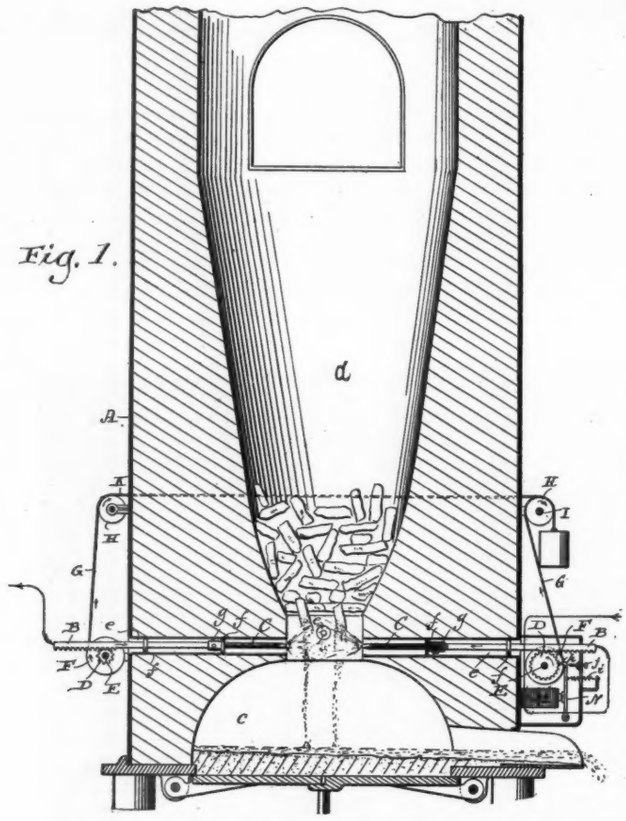


KJELLIN ELECTRIC FURNACE IN OPERATION

Electric furnaces are now being installed in some of the best iron and steel plants in America for use in connection with existing methods, and electric current being so extensively used in these plants for power transmission and distribution about the works, is easily made available for this new purpose.

It may therefore be of interest to note some of the types of electrical iron and steel furnaces invented by American engineers as well as those of Great Britain and Europe. A number of American electric furnaces have been designed and built and also some furnaces have been perfected by foreign engineers. A few of the most successful will be described and data given as to the results of tests made.

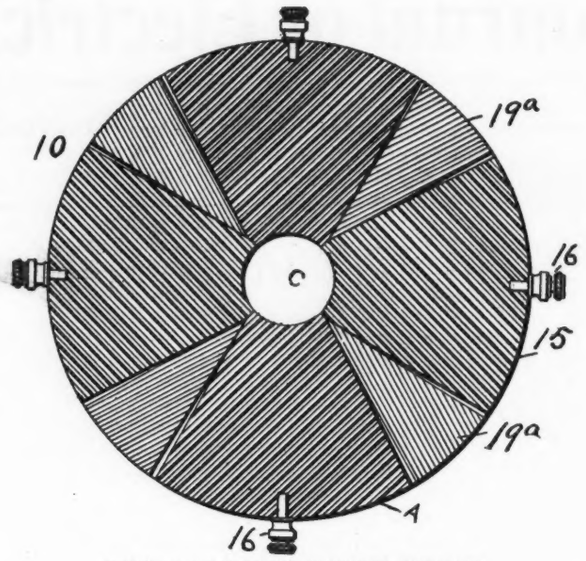
Fig. 1.



VERTICAL SECTION OF THE SHAW ELECTRIC FURNACE

About ten years ago an electric furnace for melting pig iron, scrap iron, and iron ore was designed by Solomon Shaw, consisting of a cupola provided with the usual receptacle for the material to be melted. This is of a concave rounded form at the bottom which supports the mass of ore or metal, and has a passage leading into a lower chamber, which receives the material discharged from the upper receptacle. At the bottom of the lower chamber two hinged traps are arranged to overlap each other at the center, forming a fluid-tight joint and supported by a removable post or support which is removed, allowing the traps to be opened when it is desired to clean the chamber.

In one form of the Shaw furnace the electrodes are placed in the lower part of the upper receptacle, while in another design the electrodes are located at the passage leading from the upper to the lower receptacles, and they are automatically adjusted. In this furnace flues are provided which lead from the lower portion back into the ore chamber of the cupola. In this furnace it was claimed by the inventor that iron or scrap could be more satisfactorily melted than if the material were permitted to descend rapidly through the receptacle without being retarded at the lower end. He also claimed to be able to melt iron ore without the use of a flux, the ore simply being passed between the poles of a voltaic arc and acted on directly by the electric current.



SECTION OF CONLEY ELECTRIC FURNACE

The illustration shows the form and arrangement of the electrodes and in the electric furnace invented by Michael R. Conley, in which he claims that the iron ore can be reduced at one operation. It is also stated that the furnace is of small first cost, while the heating parts may be adjusted as they wear. The electrodes do not protrude into this furnace, thus reducing the attack upon the carbons by the oxygen of the ore and the early burning out of the electrodes. In this design a heating or incandescent zone is produced in a relatively narrow part of the furnace, and no attempt is made to produce an arc, the ore as it melts passing down to the hearth where the electrodes are arranged to keep the metal liquid until it is tapped. This electric furnace is constructed principally of fire brick and is of cylindrical shape, the interior body portion being reduced to form a neck, which is smaller in cross section than any other part of the furnace, and below which is a relatively large hearth, which is provided with the usual tap hole and the ordinary openings for the removal of slag.

The walls of the neck constitute a melting zone formed of electrodes which are arranged in the same horizontal plane. Opposite the hearth and forming practically a heating zone around it are other electrodes which are formed of a material containing sufficient carbon to offer resistance to the current of sufficient magnitude to heat the electrodes to incandescence. The best electrodes consist of a composition of plumbago as a principal ingredient, mixed with clay, somewhat as plumbago crucibles have for a long time been made. Mr. Conley in speaking of his furnace says:

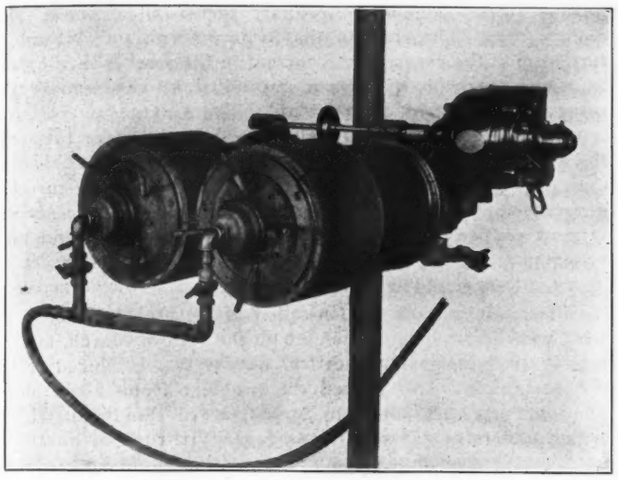
"The nature of the ores can be ascertained in the usual way, and the right quantity of carbon, such as coke or charcoal, mixed with the ore as it is fed to the furnace, so that the ingots, as they are cast, will contain the right percentage of carbon. This can be accurately determined so as to produce a quality of steel sufficiently good, at any rate, to make ordinary commercial ingots.

It will be seen that the structure provides for melting ore or metal without the disturbing influence of the arc, and that where the ore is decarburized at the upper heating zone, that is, in the neck of the furnace, it can be recarburized or treated with manganese or other ingredients, if desired in the bath."

The electric smelting furnace, designed by F. C. Weber, and patented by him in 1902, has a horizontally elongated furnace chamber with several superimposed series of electrodes projecting laterally into the furnace, each series having a different angle of downward convergence in relation to the other series.

These electrodes thus form an extended horizontal arcing space projecting downwardly between the several series. A feed or discharge for the material from above is in a direct line with the arcing space.

Mr. Marcus Ruthenburg of Philadelphia several years ago invented an electric furnace peculiarly adapted for smelting and refining ores, and has since that time designed other furnaces and an electrical concentration process of great value, which have been installed in various plants at Lockport, N. Y. and Lebanon, Pa., as well as in the new plant of the Salisbury Steel and Iron Co. at Herkimer, N. Y.



RUTHENBURG ELECTRIC FURNACE

The Ruthenburg electric smelting and refining furnace is not an intermittent furnace in which the material is alternately charged and discharged with respect to the hearth, but a construction is provided which permits of a continuous operation with the idea of increasing the output. It is claimed by the inventor to be particularly adapted for the agglomeration of comminuted ores or concentrates, and so arranged as to insure the positive discharge of the agglomerated product from the furnace with a minimum expenditure of power.

The above furnace, as well as a recent design of the Ruthenburg electric furnace, wherein the material treated is fused within a magnetic field, is shown in the illustration. The earlier form comprises movable electrodes or terminals of a heating circuit, and means to cause the movement of these electrodes during the operation of the furnace; the progression of the raw material is thus secured as well as the automatic discharge of the product. This furnace has a hopper constituting one terminal of the electric heating circuit and a roller for the other terminal. An electric motor is provided for operating the roller and water jacket spaces are provided for cooling the parts of the apparatus liable to become overheated, to their detriment.

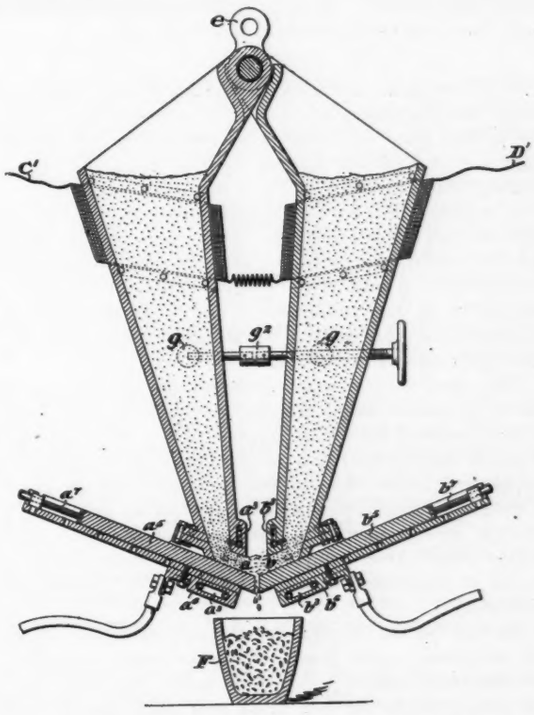
The furnace shown provides for the fusing of the ore vantageous, in that intimate particles of the material treated in a magnetic field. Such an arrangement is particularly advantageous, in that intimate particles of the material treated are secured directly between the opposite electrodes of the fusing circuit and the greatest temperature is produced within the ore instead of at the approximate surface of the electrodes, as is the case with many other furnaces.

In the Ruthenberg furnace there is formed a magnetic field at the fusing region of the furnace by making the opposed electrodes of the fusing circuit cores electro-magnets, with tubular cores, which serve to convey the material to be treated to the fusing region. The finely divided ore passes through openings of the electrodes which are of a magnetisable nature, such as cast iron. They constitute electromagnets of opposite polarity, being energised by coils and the electrodes are insulated from each other and supported upon a shaft.

The electrodes, being insulated at their upper extremities, cause the fusing current to be conveyed by the conductors to traverse the gap between orifices which may be increased or diminished in length by the adjustment of a bar and wheel. This bar is insulated at the collar between the electrodes, and in order to protect the terminals, water jacket spaces are left where the ore leaves the openings. As to the working of his furnace, Mr. Ruthenburg says:

"The raw material, comminuted iron ore for instance, being magnetized, becomes a part of the core of the electromagnets of opposite polarity at the fusing region, and by the stress of the magnetic field is positively progressed through the electrodes and caused to bridge the gap between the orifices in the electrodes. However, the form of the fusing bridge across the gap is, of course, dependent upon the nature of the materials treated and the extent of the gap, the latter being adjustable at the will of the operator. The effect of the magnetic bridging of the gap is to localize the highest temperature within the mass of material extending across the gap between the electrodes, from which the fused product gravitates in globules or irregular lumps. The rate of discharge is determined by the rate of progression of the raw material to the fusing region between the electrodes."

In one form of the Ruthenburg furnace the magnetic field between the poles at the fusing point forms the sole support for the material, while in another design the furnace floors of the carbon or other material are provided between openings, these being arranged to be replaced as they burn away and disintegrate. Mr. Ruthenburg has also designed a means of positively progressing the material by means of a

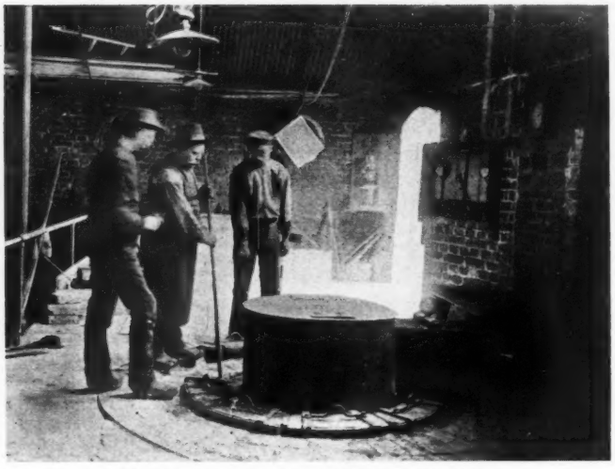


VERTICAL SECTION OF THE RUTHENBURG ELECTRIC FURNACE

rotary screw conveyor which is provided with belt wheels. Even though it has been stated by many engineers that any process of electric smelting of iron ores will have great difficulty in competing with the latest blast furnace construction using high power gas engines which utilize the waste gases, yet companies have been formed in the United States for the utilization of the electric furnace, and existing steel plants are

installing electric concentration plants as well, and conclusive data will probably be obtainable at no great distant date.

The electric furnaces installed and in use at Gysinge, Sweden, were designed by Mr. F. A. Kjellin, the furnace last constructed holding 1,880 kgs., and when charged with cold raw materials is capable of producing 1,500 tons per year. The new furnace is supplied with current from a large single-phase alternating-current generator recently installed in the power plant and operated by a vertical turbine which works under a head of only 3 meters, or about 10 feet. This turbine has a speed of 75 revolutions per minute and develops 300 horsepower. It is directly coupled to a vertical shaft alternator which generates single-phase current at a pressure of 3,000 volts.



EXTERIOR KJELLIN ELECTRIC FURNACE

The accompanying illustrations show the interior of the electric furnace room, showing the side of the electric furnace at the time of drawing off the liquid steel, and also shows the top of the Kjellin electric steel furnace as the charging of the raw material is about to be undertaken.

It is maintained by Mr. Kjellin that in resistance furnaces with electrodes the steel very easily takes up the impurities from the electrodes consumed, and the cost of the electrodes increases the expense of the output, while the carbonic oxide resulting from the oxidation of the electrodes has a very bad influence by preventing the steel from giving off the carbonic oxide dissolved in it.

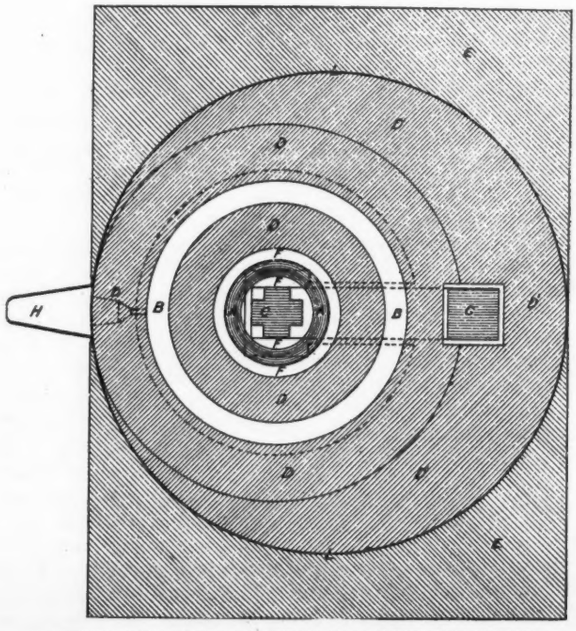
The steel can be more uniformly heated by passing an electric current of many amperes through the steel and using the heat evolved by the resistance of the steel for smelting. He states that as the resistance of the metals when molten is comparatively low, the current used must be so great that the copper cables have a section at least as great as that of the steel in the furnace. The Swedish inventor, DeLaval, tried to avoid these difficulties by using molten slag instead of steel as resistance in his furnace, but the result was not satisfactory.

As the carbon electrodes in furnaces of this kind have high resistance, great losses of power result. Water-cooled iron electrodes might be used, possibly, but then the magnetic properties of the iron cause new difficulties to arise. In order to get sufficient intensity of current, alternating current must be used, and then the magnetization causes the concentration of the current at the surface of the electrodes, and the result is increased impedance in the conductor. On account of inductance the maximum capacity of the generator is also diminished. In May, 1899, in Stockholm, Sweden, Mr. Kjellin proposed to Mr. Benedicks, general manager for the Gysinge works, to eliminate these difficulties by constructing an electric furnace without electrodes. This was accepted, and the furnaces were built, as shown in the illustrations.

A groove forms the furnace chamber, the sides and bottom of which consist of refractory bricks, the whole being provided with a suitable cover. A quadrangular iron core formed of thin insulated sheets of soft iron is in the center of the circle formed by the furnace chamber, and this is enclosed by a coil of insulated copper wire. The core continues outside the furnace and forms with the furnace chamber the two links of the chain. An alternator is connected with the coil and the current, when passing through the coil, produces a varying magnetic flux in the core, and this flux induces an alternating current in the contents of the furnace chamber. The operation is, in fact, similar to a step-down transformer having a large number of primary turns and a single secondary turn. The steel in the furnace forms only a single turn around the core and the current in the steel is then equal to about the primary current multiplied by the number of turns of wire in the primary coil. The voltage of the current in the steel is, of course, reduced in the same ratio as the number of amperes are increased. It will thus be seen that it is possible in this way to use an alternating-current generator of high voltage, and yet no transformers are necessary or copper cables of large section. The costly and uneconomical carbon electrodes are also avoided, and yet a heavy current is obtained in the furnace with a low voltage.

The first furnace was installed at Gysinge in February, 1900, and the first ingot was cast on the 18th of March, and it is said that steel of an excellent quality was produced from the beginning. This solved the problem from a technical point of view, but not from a commercial standpoint, since with a generator of 80 kilowatts capacity it took 24 hours to produce 270 kgs. of steel, or 7 kilowatt-hours per kg. In November of the same year another furnace was constructed which produced 700 kgs. of steel in 24 hours with 58 kilowatts, or less than 2 kilowatt-hours per kg, the charges being 100 kgs. every three or four hours. On account of the cooling surface of the walls being too large in comparison with the contents of the furnace, the output was not satisfactory and the cost of repairs was excessive.

In August, 1901, a fire destroyed the sulphite pulp mill at Gysinge, and instead of rebuilding the same, the water-power was utilized for steel-making by electric smelting and a new plant was constructed for this purpose. This electric steel furnace plant was started in 1902, and since May of that year has worked most satisfactorily. The furnace shown in the illustrations has a capacity of 1,800 kgs. of steel, 1,000 kgs.



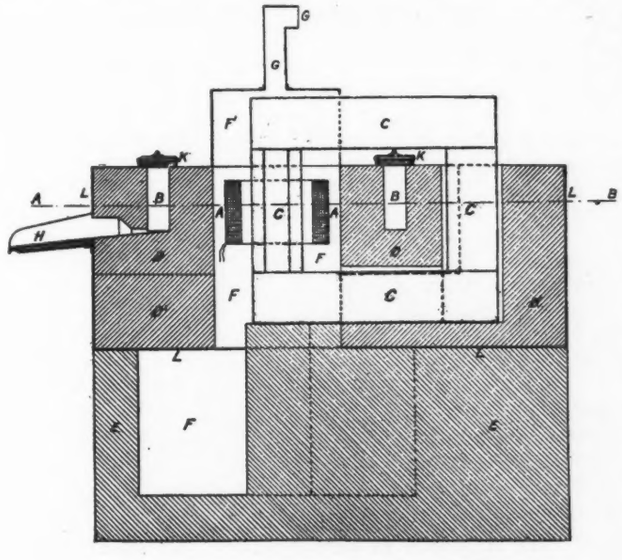
HORIZONTAL SECTION KJELLIN ELECTRIC FURNACE

being drawn off at once, the remainder being left to keep the current flowing. It produces 4,100 kgs. of steel ingots in 24 hours when charged with cold material, using 165 kilowatts, or very nearly one kilowatt-hour per kilogram.

A single-phase alternator is used which generates at 3,000 volts. This single-phase current is transformed by means of the primary coil and iron core of the furnace into a current of about 30,000 amperes in the steel that forms the secondary circuit.

At Gysinge there is produced only first-class steel from excellent Dannemore pig-iron and wrought-iron. The method of operation is as follows: When the steel has been drawn off and about 800 kgs. left to keep the current flowing, the furnace is charged with pig-iron and bar ends, as well as steel scrap, in such proportions as experience has proved will give the percentage of carbon desired. The resulting steel always has less carbon than the material charged, since the pig-iron is usually more or less rusty. When the charge has melted and overheated to a proper degree, the metal is drawn off by tapping, in the same way as at the open hearth furnace, through a hole in the wall of the furnace. As will be noted by the illustrations and drawings, the upper part of the Kjellin electrical furnace is on the same level as the working floor, and the charging is accomplished by simply taking off the covers and putting in the material. As the heat is produced in the steel itself, the slag is not so hot as in other steel furnaces, and so the workmen do not suffer from heat to the same degree.

It is stated that the steel produced is of an uncommonly dense and excellent quality, being homogeneous and unusually tough. It may be easily worked cold when annealed and is



VERTICAL SECTION KJELLIN ELECTRIC FURNACE

not disposed to crack or warp when hardening, as with other kinds of steel. Mr. Kjellin thinks the reason for this is that the steel contains less gaseous matter than other steel, as even small quantities of gases, especially hydrogen, are harmful. He has the following to say in reference to the avoidance of gases in the product from the Kjellin furnace and as to the cost of production of steel ingots:

"By the electric furnace described above the steel has no opportunity of taking up such gases or other impurities, and the quality is also better than that of crucible steel with the same analysis. To make special steels with nickel, tungsten, or chromium offers no difficulties and the alloys are quite homogeneous. The cost of production depends principally on the efficiency of the furnace and the price of power. At the furnace now in use at Gysinge the losses have been experimently proved to be 87.5 kilowatts, so that the effective power absorbed by the steel is 165 — 87.5 = 77.5 kilowatts, and as that produced 4,100 kgs. of steel in 24 hours, one effective kilowatt produces about 53 kgs. of steel ingots in the same time. Every kilowatt more in the furnace when the size is not altered increases the output with 53 kgs of steel, and we intend within a few months to install a larger waterwheel to produce about 6,000 kgs. of steel ingots with 200 kilowatts in 24 hours. As the absolute cost of labor and repair will be the same, the cost for one ton of steel ingots will be about two-thirds of the best now produced and the price of power per ton will be also materially diminished

"The cost of labor and repair for such a furnace will, in my opinion, be less than those of an open hearth furnace of the same size, so that where power is cheap there is a possibility of producing a steel competing with the expensive crucible steel at a smelting cost not exceeding that of the open hearth furnace."

An estimate of the total cost of producing the steel by the electric furnace is $42.89, assuming 165 kilowatts for 4,100 kgs. of steel in 24 hours. The cost of 1 horsepower being assumed at .375 cent would make the cost of the power $5, the wages being $2.50 and the cost of the charge $32.50. The depreciation and interest is estimated at .56 cent and the cost of repairs and brick work $2.08, while the cost of the mould is taken as .25 cents. The cost of the charge would be considerably higher if chromium and other expensive material were added, the above estimate being the cost for soft iron and pure charcoal and pig-iron. A lining of silica or magnesia stone may be used in this process, as the fire gases do not come into contact with the steel, even by diffusion. An analysis of one grade of steel made at Gysinge shows a composition of sulphur 01 per cent, phosphorus with .49 per cent of manganese and .47 per cent of silicon, the carbon being represented by 1.45 per cent. The cost of building the electric furnace is given as 1,500 Swedish crowns, and it has a capacity of about one ton, the ordinary steel crucibles usually employed holding about 40 kgs. of metal.

In a paper read at a recent meeting of the Iron and Steel Institute of Great Britain, E. C. Ibbotson has given definite information regarding the output and cost of steel manufactured at Gysinge, using the Kjellin electric furnace. During the year ending May 31, 1906, from a fixed furnace giving 2,240 pounds of steel per tap, there were produced 950 tons of steel and special steel ingots. In carbon and iron tool steel all the usual tempers were made. The bulk of this steel was made from charges composed of 80 per cent of Swedish white pig-iron and 20 per cent of steel scrap iron. The percentage of carbon was regulated by the addition of briquettes. Other charges were made from Swedish white iron and steel scrap iron.

The average time required for each charge, covering the year, when adding briquettes, was 7⅛ hours, and the electrical energy consumed was 1,128 kilowatt-hours per ton. The average time per charge for white iron and scrap charges was 5½ hours, and the electrical energy consumed was 886 kilowatt-hours per ton. These figures given include all the time and energy lost from various causes, such as inferior water supply, ice, etc., in the hydro-electric plant.

Under ordinary circumstances, 6½ hours is required to complete the charges with briquettes, and 5 hours without briquettes.

For the operation of the furnace during the entire year magnesite was used as the lining. When using briquettes the lining under ordinary conditions lasts about five weeks, and when charges are worked without briquettes the average life of the lining is seven weeks.

Many tests have been made of the steels produced in this furnace, and in most cases the results are extremely satisfactory. During the year the best results were obtained when the steel produced was used for the following charges:

Stamping dies, punches, cold chisels, screwing dies and taps, cutlery, drills and turning tools.

The following special steels have also been produced: Tungsten steel (including permanent magnet steel), chrom-

ium steel, nickel-chromium steel, self-hardening steel and high speed tool steel. Some of the latter was tested to the requirements of the latest government specifications and gave most satisfactory results, while 25 per cent unannealed 2-inch nickel steel bar ½ inch in diameter gave a yield point of 30.68 tons per square inch, a maximum stress of 50.44 tons per square inch in an elongation of 44 per cent and a reduction of area of 60 per cent.

Electrical tests carried out have shown that No. 6 gauge rods have a special resistance of 36 microhms per cubic inch, while No. 16 gauge wire has a special resistance of 33.5 microhms per cubic inch.

THE FLAMING ARC LAMP.

Among the new illuminants to attract the attention of the central-station man is the flaming carbon arc lamp. The new lamp is only just beginning to be appreciated in this country, though its use has become comparatively common in Europe. While it possesses several inherent disadvantages, it is none the less true that for certain classes of illumination, notably street lighting, it has much to recommend it over the ordinary arc lamp, and may prove a valuable agent in meeting gas-lighting competition.

Heretofore one of the objections to the flaming arc has been the emission of fumes and vapors which have made it objectionable, especially for indoor purposes. In the later types, however, this objection is overcome by the use of what is termed an economizer, upon which the vapors arising from the arc are condensed. Some types of the lamp also make use of a special form of condenser to receive the vapor deposits. These deposits are whitish in color and they collect on the under surface of the economizer or condenser, thus aiding materially in reflecting the light in a downward direction.

From careful measurements, it has been determined that the flaming arc gives a little over five times the total luminous flux of the enclosed arc lamp, using the same amount of power at the arc. For street lighting, the yellowish tinge of the light emitted by the flaming arc is highly efficient, but for interior lighting, where color values are important, the yellow light is objectionable, as under it white colors appear cream-colored, shades of yellow are intensified, and the color values at the violet end of the spectrum are much distorted. Figures recently given by an investigator show that when the station cost of producing energy is less than 2 cents a kilowatt-hour, and the price of the flaming arc carbons 10 cents a trim (which is one-third less than the present cost in this country), it would not pay to install the flaming arc. When the cost of energy is higher, however, the flaming arc is economical, particularly if the cost of the carbons is reduced, which is likely to be the case.—Western Electrician.

FIVE-CENT LIGHTING RATE DECLARED TO BE TOO LOW.

Judge Thompson in the United States Court at Cincinnati has rendered a decision approving of the finding of Master Commissioner T. P. Linn against the city of Columbus in passing an ordinance requiring the Columbus Railway & Light Co. to furnish light at 5 cents per kilowatt-hour. The master commissioner found that the ordinance was unconstitutional, as the price fixed was so low that it amounted to confiscation of property. The court allowed the master commissioner a fee of $6,000, which will have to be paid by the city unless it should win out in the higher courts. City Solicitor George S. Marshall, it is stated, will carry the case to the Supreme Court if a decision in favor of the city is not reached before.

OVERHEATING OF BOILERS.

A common impression prevails that it is dangerous to employ abnormally high temperatures, or to apply heat in too concentrated a form to boiler furnaces owing to the liability of the furnace plates or tubes to become overheated and seriously weakened, rendering the boiler unsafe to work.

The researches of Blackynden, Durston, Hirsch, Witz and Miss E. M. Bryant, B. Sc., amply prove that this idea is entirely without foundation, provided the heating surfaces are kept clean and the internal surfaces free from scale and grease, and these are essential conditions of first importance in any boilers designed for high duty.

From his experiments, Hirsch concluded that sound and clean plates in a boiler could not be overheated so long as water was being evaporated from them at rates up to 75 pounds per square foot of surface per hour; and Miss Bryant in her investgations on "The Thermal Condition of Iron, Steel and Copper when Acting as Boiler Plates," demonstrated that at 50 pounds per square foot evaporation a ½-inch plate has a temperature of 303 degrees Fahrenheit, and at 70 pounds a temperature of 338 degrees Fahrenheit.

Present practice with modern boilers reveals the astonishing fact that the average evaporation amounts to from 2½ pounds to 7 pounds, rarely more, and, say, exceptionally to 10 or 12 pounds of water per square foot of heating surface per hour. Until this rate is very much increased, boiler-house plant cannot be considered as worthy to rank alongside present-day engine-room equipment.—Electrical Review, New York.

ELECTRICITY BY WINDMILLS.

Tests upon windmills for producing current have been carried out for the Danish government by Professor La Cour at Askow, with very good results. With a four-wing wheel, which he finds to be the best form, using 15 square yards surface and a wind of 20 feet per second we obtain 2 horsepower. A wind-speed of 35 feet per second gives about 10 horsepower. In order to provide a reserve during an absence of wind he finds that a small petrol motor which can be coupled to the dynamo is the best to use, as it costs much less than a storage battery. At Askow he has been running a windmill plant which fed 450 incandescent lamps, with some arcs and motors. Such a plant costs $4,700 to erect, including the price of the ground, and it costs $165 per year to operate it. A plant of this kind would be very good for farm use, and a much smaller one would answer in many cases, costing in the neighborhood of $1,000. A number of windmill electric plants of this kind are now running in Denmark.

THE ALASKA-YUKON-PACIFIC EXHIBITION.

A $10,000,000 fair to be held in Seattle, Wash., in 1909 seems a certainty, if one may judge from the material enthusiasm of the Seattle folk. In one day, especially set aside for the purpose, they bought shares in the proposed exhibit amounting to $650,000.

The object of this exhibit is to bring together the products of Alaska and the Yukon country, Asia, Oceanica and America. Much of the exhibit will probably be devoted to Alaska, since it is desired to make the general public better acquainted with the resources of that territory.

The grounds of the University of Washington, comprising 355 acres and bordering on Lake Washington and Lake Union, are well adapted to the purpose and conveniently situated, since it is but a twenty minutes' ride from there to the heart of the city.

DISCOVERY AND INVENTION.*

(By Edward Goodrich Acheson.)

The invitation to appear before you was presumably given on the assumption that I would speak upon some subject interesting to you as engineers and having relation to my own work, one to which I might, perchance, add points of value or interest over and above that obtainable from the public storehouse of knowledge. After giving the subject considerable thought, I determined on confining my remarks to Discovery and Invention, as closely related to my life work, preluding the references to personal work with a brief glance at a few noted examples of **Discovery without Invention; Invention without Discovery; and Discovery with Invention.**

Discovery.—"The act of finding out or of bringing to knowledge what was unknown; first knowledge of anything" —is usually without meditation, it is accidental; true, the finder may be engaged in a search for conditions of things of the general nature of the discovered, but it would not be a discovery did he know or have reason to believe it existed under the conditions or in the place he found it. He may be likened to the traveler who casually picks up a rough, uncut gem. The inventor is the lapidary who finds a use, a place for the gem. It is he who with labor, care and expenditure of gray matter polishes and beautifies the rough stone. His work is to create, not simply to find.

In 1831 Michael Faraday while trying to find a constantly flowing current in a wire lying beside and parallel to another wire through which a current of electricity was flowing, noticed when the wires were coiled upon an iron ring that a momentary kick or swing of the needle of the galvanometer to which the dead wire was attached occurred upon opening or closing the circuit through the live wire. He followed up these observations with experiments extending over a period of ten days, and on the 29th day of November, 1831, while at Brighton resting from his labors, wrote his friend, Mr. R. Phillips, as follows: "We are here to refresh, I have been working and writing a paper that always knocks me out in health, but now I feel well again, and able to pursue my subject; and now I will tell you what it is about. The title will be, I think, 'Experimental Researches in Electricity.' I. On the Induction of Electric Currents; II. On the Evolution of Electricity from Magnetism; III. On a New Electric Condition of Matter; IV. On Arago's Magnetic Phenomena. There is a bill of fare for you, and what is more, I hope it will not disappoint you. Now the pith of all this I must give you very briefly, the demonstrations you will have in the paper when printed."

Such was the simple homely language used by this truly great man in referring to one of the most momentous discoveries of the ages. Faraday made this discovery at the very close of the fortieth year of his life; he died in 1867, or thirty-six years after that eventful period, crowned with great honors for his scientific investigations, and yet without having witnessed the remarkable applications to the world's industries, wealth, and, shall I say, happiness, of the great fact of electric induction which he had discovered. For something like forty years it awaited the inspiring touch of invention. Today we have with us the telephone, the electric light, the electric railway, and many more necessities and conveniences that were only made possible by this discovery of Michael Faraday. This I take to be an apt illustration of **Discovery without Invention**, that is to say, by the discoverer.

Another illustration of **Discovery without Invention** is, I believe, to be found in the history of the telephone. Without wishing to detract in any way from the honors of Prof. Alexander Graham Bell, to whom the world today is greatly indebted, I believe this very valuable invention, if it now existed as or consisted of the parts as produced and left by him, would be practically a toy, truly a very interesting one, but incapable of the marvelous use to which it is now put. His keen observation recognized that a disc of iron caused to approach and recede from a magnet in consonance with the air waves of spoken words, would produce currents of electricity in a wire surrounding the magnet, varying in intensity with the air waves moving the disc, and he further discovered that these electric currents, when made to pass around a second or similar magnet having a like disc of iron in close proximity to its end, caused the disc to move and buckle in response to the currents and thereby produce air waves like the original ones and consequently articulate speech. It required the inventive genius of Edison, Dolbear, Blake and others to put this discovery into the commercial forms of today.

An illustration of **Invention without Discovery** is shown by the great invention of Sir Henry Bessemer in 1856. This consisted, as you know, in blowing air through melted cast iron, thereby burning out the carbon and converting the metal into a malleable product. For this he was made a Fellow of the Royal Society and received knighthood in 1879.

Some years ago it was customary and necessary to employ expert telegraphers to pick up a message from one wire and transmit to another one where long distances were covered. In one of the repeating offices situated in the Middle States was a young expert operator by the name of Thomas Edison. One day, or night, one of his superiors at the office entered the room and found young Edison sound asleep, while a small inanimate instrument was industriously performing his work, performing it even better than Edison personally could have done. Shortly after this unheard of neglect of duty Edison was looking for another job. This was certainly a beautiful example of applied known principles. Much to the advantage of the world, Edison's inventive genius was not daunted by this rebuff. By his Quadruplex System, he practically quadrupled the capacity and value of the telegraph wires of the world.

The development of the telephone above referred to, likewise the electric light and many other instances that will occur to you, are cases of **Invention without Discovery.**

Discovery with Invention is strikingly illustrated by the work of Charles Goodyear. The life of this remarkable man is most interesting, and feeling sure that it will meet with your approval, I venture to quote from the National Cyclopaedia of American Biography much of the following history:

Charles Goodyear was born December 29, 1800. His father was in the hardware business at New Haven, Conn. When still a young boy he one day picked up a scale of India rubber that had peeled from a bottle. He at once conceived the notion that it would be very valuable if it could be made uniformly thin and rendered free from cracking, sticking and melting with variations of temperature. When he reached his majority he entered into partnership with his father. In 1826 he went to Philadelphia to represent his firm. Four years later they failed in business, and during the succeeding ten years he was repeatedly imprisoned for debt. In 1831 he became again interested in his rubber project. Strenuous effort had been made by others to cure rubber and make it serviceable as a fabric, and to that object he now devoted his life. He met with no real encouragement of success for the first four years of his investigations, which were seldom carried on out of prison. He became at last the butt of those who could not share his faith. He remained calm, patient, assured of ultimate and lasting success, he and his family literally living from hand to mouth, sometimes selling his children's books and pieces of household furniture to meet the calls of hunger. In the early months of 1839 relief came in his discovery of a process by which high degrees of heat applied to rubber, which had been coated with sulphur, brought about the vulcanization of the raw material, so that it kept elastic in all temperatures. Before his death, which occurred on July 1, 1860, he saw vulcanized rubber applied to nearly five hundred different uses, and 60,000 people engaged in making the articles into which it was fashioned. It has been said:

* A lecture delivered before the engineering students of Cornell University

"No inventor, probably, has ever been so harassed, so trampled upon, so plundered by pirates as he—their spoilations upon him having unquestionably amounted to millions of dollars."

Before touching upon my own latter work, I wish to reminisce a little, and trust what I may say will be found sufficiently interesting to justify detaining you and illustrate the possibilities before a young man.

Leaving an academy in 1872 in my seventeenth year, I became a timekeeper at a blast furnace; I later joined a civil engineer corps on railroad construction; then was ticket clerk on a railroad; again I was civil engineering on a railroad; then measured and computed the capacities of oil tanks in the oil country; then was for a time bookkeeper; then mined iron ore for a living, and on the first day of September, 1880, I left Western Pennsylvania for my first trip to New York City with the avowed intention of obtaining electrical work. The twelfth day of the month saw me located with Mr. Edison at Menlo Park as assistant draftsman. Within a few weeks I had formed the personal acquaintance of Mr. Edison and was moved from the drafting room to the original experimental department. In the following winter Mr. Edison, who was strenuously endeavoring to find the best material for the filament of his lamp, directed me to experiment upon the production of a filament of graphite. He encouraged me by promising me a prize of $100 when I succeeded in making a flat loop of graphite measuring one inch outside diameter, the filament to be twenty-five-thousandths wide and two-thousandths of an inch thick, the same being capable of mounting in a glass globe.

With proper facilities for purifying the graphite, hydraulic press for pressing sheets and dies for cutting out the loop, I made about 16,000 of these filaments, having succeeded in making them one-half what was requested by Edison, or one-thousandths of an inch thick.

On the 20th of the following July I sailed out of New York harbor as first assistant engineer for the Edison interests at the Electrical Exposition in Paris, and later had the pleasure of installing the first commercial incandescent lighting plants in Holland, Belgium and Italy.

In the latter part of the year 1880 I had brought to my attention the value of an abrasive material by a remark incidentally made by Mr. George F. Kunz of Tiffany & Co., New York. While making some experiments in 1886 I passed a quantity of hydrocarbon gas over highly heated clay, and observed that the clay became impregnated with carbon, and I thought it was increased in hardness by the presence of the carbon. In the early part of the year 1891, having at my command an electric generating plant of considerable capacity, and looking about for a line of experiments, I thought to try the impregnating of clay with carbon under the influence of the high heat obtainable with the electric current. I mixed together a quantity of clay and powdered coke, placed the mixture in an iron bowl such as plumbers use for holding their melted solder. Into this mixture I inserted one end of an electric lamp carbon, the other end being connected to one lead from a dynamo, the other lead being attached to the iron bowl. A good strong current was sent through the mixture until the central portion of the clay was thoroughly melted. When cold the mass was removed and examined carefully, adhering to the end of the carbon rod I noticed a very few small bright specks, and with difficulty secured one, and placing it on the end of a lead pencil, drew it across a pane of glass. It not only scratched but cut the glass. I had found the rough uncut gem.

Appreciating the possible value of my discovery, and not withstanding the exceedingly minute quantity of crystals produced, I undertook further experiments, and if not mistaken, two months or more had passed before enough crystals had been produced to fill a small vial measuring about ⅜ inch by 1 inch. Having filled the little vial, I placed it in my vest pocket and went to New York, where I had a diamond cutter use some of my new material for the repolishing of diamonds. While on the way to New York I had named it Carborundum under the belief that it contained carbon and corundum. The diamond cutter bought what was left of the material at the price of 30c per carat, and with the proceeds I purchased a microscope to assist me in the further study of the material.

Soon after this I learned that it was the silica in the clay and not the alumina that was associating itself with the carbon, so before long I had quit the use of the clay and was substituting sand.

I had devised an electric furnace in which a resistant material formed a central core around which was placed the material to be heated, and this probably was the first furnace wherein thermal and chemical effects were produced within the mass of material operated upon, the outer portions of the mass acting as retaining walls. It is thus that we can work at higher temperatures than would be possible were we required to depend upon the furnace walls proper.

The history of the development of Carborundum is overflowing with trial, tribulations and glorious triumphs. In 1894 the Carborundum Company, a company I had formed to develop the business, was located at Monongahela City in Western Pennsylvania, and it was operating a steam generating plant of 134 horsepower. The cost of production was so high that the trade was restricted to lapidaries, valve grinding, and kindred lines that could afford to buy it, and but one-half its production was sold. The new electrical development at Niagara Falls was at this time approaching completion. I went to Niagara Falls, looked over the situation, possibilities and prices. On my return I convened a meeting of the Board of Directors and laid before them a scheme of moving to Niagara Falls and there building and equipping a plant for 1,000 horsepower. To build a plant for 1,000 horsepower, in view of the fact that we were only selling one-half of the output from a 134 horsepower one, was a trifle too much for my conservative directors, and they one and all resigned, arose, and left the room. A new board was organized and plans proceeded with, and in the year 1904, the thirteenth one from the date of the discovery, the Carborundum Company had a plant equipped with 5,000 electrical horsepower, and produced over 7,000,000 pounds of these specks that had been picked off the end of the electric lamp carbon in the spring of 1891.

It has been held as an opinion by some that my work on Carborundum was simply an extension and development of the work of P. Schutzenberger, and in this connection I wish to say that some time after I had made my original experiments on Carborundum and knew the substance to be the compound SiC, I learned that Schutzenberger had produced such a compound. On investigation I found he had communicated to the Academy of Sciences of France on Monday, May 16, 1892, the results of his work under the title "Contribution to the History of Carbo-Silicon Compounds." This communication was made some three months later than the date on which Mr. Nikola Tesla exhibited a lamp containing carborundum (which I had made and furnished him) before various scientific societies of Europe. Furthermore, Schutzenberger describes his experiments as having been made with a mixture of silicon and silica placed in a bone-black crucible, the latter covered with a lid of like material and embedded in lampblack contained in a larger crucible; this again being embedded in a third crucible. The rest was placed in a furnace brought up to a high heat and retained there for some hours. Upon cooling and opening, the contained silicon was found to have been changed to a green substance, and to have gained in weight an amount equal to one-half of its original weight, the silica remaining unchanged. An analysis showed the green material to be carbide of silicon with the formula SiC. You will notice the silica remained unchanged, consequently his work had no relation to mine nor mine to his.

Some years ago I discovered that when Carborundum was heated to a very high temperature, decomposition occurred, the contained silicon was dissipated in vapor and a beautiful graphite left as a pseudomorph, or as I was pleased to call it, a skeleton of the original carborundum crystal. This discovery started me on a new line of thought, and as a result of a long series of experiments, the present methods of the International Acheson Graphite Co. were perfected. The development of the business has been phenomenal. The products of this company in the form of rods, bars and plates are extensively used by the electrochemical and electrometallurgical industries, almost to the entire exclusion of amorphous carbon, which they formerly used, not only in America, but throughout Europe. In the pulverized form, it is used extensively as a filler in dry batteries. It is rapidly growing in favor for stove polish, lubrication, foundry facings, and as a paint pigment. It is particularly well adapted for paint, being a very pure form of carbon, free from oxides and readily reduced to a very fine powder.

It is possible to produce practically chemically pure carbon by our methods, but the cost increases as this condition is approached, and for commercial purposes the purity of 99.5 per cent is adopted for electrodes for use in electrochemical and electrometallurgical work, while for the paint and kindred uses 97 per cent is the standard. When it is remembered that a good quality of natural graphite contains but 85 per cent carbon, while most of that sold in the market runs as low as 45 per cent, it will be appreciated that our product is unique. For electrical work it is almost ideal. A rod or bar of this graphite is graphite throughout. It is not made up of small graphite particles held together by a binding agent; it can be cut, planed, tapped and threaded like a metal; its electrical conductivity is about four times that of a similar sized rod of amorphous carbon. Its rate of disintegration in electrochemical work is very slow. In some lines of work it lasts twelve times as long as amorphous carbon.

I early hoped to introduce my newly made graphite into the crucible trade, which I knew to be a large user of the natural product. It was found to be too porous, offering too large a surface for oxidation, and my experiments on this line were not productive of success. Mr. Edison used to tell me every experiment had its value—it either accomplished the result sought for or it taught you what lines to avoid. My failure to make a successful crucible of graphite put me, so to speak, on my mettle, and from then on I was on constant watch for a suitable material, and I now hope and believe I have found one capable of making a better crucible than either graphite or clay.

The International Acheson Graphite Co. now has a plant equipped with 3,000 electrical horsepower, and during 1905 produced 2,385,123 pounds of graphite electrodes, and 1,870,411 pounds of what is termed bulk graphite, made principally from anthracite coal.

Before leaving the subject of graphite, I desire to recognize the extensive work of Prof. Henri Moissan. While in America some years ago he called on me at Niagara Falls, and I had the pleasure of conducting him through the plant of the Carborundum Co. Being at that time already engaged on my graphite work, I remember with what apparent surprise he viewed the large amount of graphite produced artificially, his own work, as you know, having been of a laboratory or experimental nature.

Prof. C. F. Burgess, in a paper read at the eighth general meeting of the American Electrochemical Society, September 20, 1905, stated that a study of the operation of the Carborundum furnace led to the discovery of a compound of oxygen, silicon and carbon, and that this compound, previously unknown, was named Siloxicon. The professor was apparently not in the possession of the facts of the case, which are as follows: During the latter part of the summer of 1899 I became interested in the direct reduction of silicon and one of my early experiments was to intimately mix, in fact, rub together, fine, soft, pure graphite and silica, so proportioned as to provide the necessary carbon for the reduction. The quantity, distribution and conductivity of the graphite was sufficient to carry the necessary current. After the current had been passed for some time, and the furnace cooled and opened, a small quantity of metallic silicon was found disseminated in and held as distinct particles throughout, a loose, bulky mass of a greenish gray substance. The loose, fluffy character of this material, together with the knowledge that it had been formed or at least existed in the path and at the temperature of the reduction of silicon caused me to immediately recognize the fact that it was what might be termed a highly refractory body. I looked upon the possible value of this newly discovered material as perhaps greater than the metallic silicon I had produced, and it was this that thereafter received my attention. Patents were, however, applied for on a direct reduction of silicon, and the right to manufacture under them was sold to the Carborundum Co. under date of July 5, 1901, and since then they have been working on this problem under the direction of their works manager, Mr. F. J. Tone.

This discovery was followed by much analytical and experimental work. The substance was found to be composed of silicon, carbon and oxygen of varying proportions, a typical formula being Si_2C_2O. It was found to be amorphous, inert to both acid and basic slags, insoluble in melted iron, self-bonding when pressed tightly together and heated to about 2,500 degrees F., and absolutely infusible, its inevitable destruction occurring as decomposition at a very high but as yet undetermined temperature, the silicon, oxygen, and a part of the carbon passing away as vapor or gas, while a part of the carbon remains as graphite occupying the space of the destroyed body, which I have named Siloxicon, from the words silicon and oxygen.

The Siloxicon Company, which I incorporated in 1903, is now engaged in developing the prospective business in its line, confining itself, however, to the manufacture of the crude siloxicon.

As an agent for the experimental work, delevopment and exploitation of the detailed manufacture of siloxicon in finished articles, such as crucibles, muffles, bricks, etc., I incorporated the Acheson Siloxicon Articles Company, and it is now actively at work upon the problems falling to its lot.

Probably never before was the world so prepared to accept and utilize a discovery, never before so ready to listen to, help and protect the inventor.

Undoubtedly many of you will be called upon to do experimental work, to investigate the unknown. If nature has not equipped you for the work of a Goodyear, uniting in you the faculties of a discoverer and inventor, be a Faraday, a discoverer, or a Bessemer, an inventor, but let me warn you, impress upon you with all the force possible, to avoid the ways of the pessimist. You will scarcely succeed if you fall in with his methods of thought. If, without previous information, you were told that it was proposed to cut into a metal plate 48,000 distinct, perfect, parallel lines per lineal inch, and that with this plate it was proposed to break up a beam of white light into the most perfect and beautiful of spectrums, what would you say? How many of you would predict failure; declare it absolutely impossible of attainment? And still these things were done by our late countryman, Prof. Henry A. Rowland. Some time ago I visited the Johns Hopkins University, and while there was conducted down into a subterranean vault, where, free from rapid or great changes of temperature, was the marvelous ruling machine invented by Prof. Rowland for making his gratings. Set in the brick wall of the vault was a bronze tablet bearing the name and dates of birth and death of Henry Augustus Rowland. I was told that back of this tablet had been placed the ashes of this remarkable man. Here in close proximity to his masterpiece was the final resting place of the earthly tenement of this master mind.

It is interesting and instructive to study and analyze the metal make-up of the Discoverer, the Inventor, and one uniting the qualities of both. Faraday was an optimist, was remarkable for a vivid imagination. He had the knack of seeing minute quantities, small things that would escape the observation of the ordinary man. Edison, as his works illustrate, clearly appreciates the possible value of the new, of a new arrangement of parts, a new application of old or new principles. He is overflowing with faith in his being able to accomplish desired ends. He sets up an objective point and with indomitable energy and perseverance strives to reach it. Goodyear combined the dominant qualities of Faraday and Edison. As a young boy his imagination pictured the sticky rubber converted into a serviceable form. He later dedicated himself to a fixed purpose. Having mixed up a little rubber and sulphur with the hope of improving the former, and not obtaining the desired end, he cast the failure into the hot ashes under the fire in his room. Later, by accident, this rejected evidence of another failure came into his hands, and was, to his surprise and undoubted delight, found to have the qualities he had for four long years been vainly hunting for. Thus he discovered that a mixture of rubber and sulphur, subjected to the heat of the hot ashes, cured or vulcanized the rubber and made it elastic at all temperatures. He evidently appreciated the commercial worth of the discovery, and witnessed the marvelous development and applications during his life.

In my own work I have been so fortunate as to have repeatedly turned failure into success. In the debris of the melted clay and carbon mixture, which proved a failure for the purpose I had in view, my attention was riveted on the unexpected bright specks. The present size of the Carborundum industry indicates my appreciation of the possible value of this discovery. Again it was not the small quantity of metallic silicon I made in my experiment in 1899 that interested me most. True, it furnished evidence of my theories of the possible reduction having been correct, but I realized that the loose, bulky material I discovered occupying the major part of the furnace might prove vastly more valuable.

Reviewing this sketch, I would sum up the dominant qualities determining the success of the Discoverer and Inventor to be: 1. Optimism. 2. Imagination. 3. Observation of small things. 4. Appreciation of the possible value of the new. 5. Knowledge of the existing art. 6. Self-reliance. 7. Having the determination to attain an end. 8. Indomitable perseverance, and I might add a 9th, (valuable particularly to the inventor). Proper assistance.

REPORT OF THE KANSAS GAS, WATER AND ELECTRIC ASSOCIATION, LAWRENCE, KAN., OCTOBER 16-17, 1906.

The Kansas Gas, Water and Electric Association held its annual meeting in Lawrence, Kan., October 16-17, 1906, 56 members of the association being present. The following officers were elected for the ensuing year: President, E. S. Springer, Leavenworth, Kan.; first vice-president, C. L. Brown, Abilene, Kan.; second vice-president, F. L. Williamson, Clay Center, Kan.; third vice-president, H. F. Jackman, Minneapolis, Kan.; secretary and treasurer, James D. Nicholson, Newton, Kan.; executive committee, John C. Nicholson, Newton, Kan.; M. A. Patten, Topeka, Kan.; F. D. Aley, Wichita, Kan.

The following papers were read and discussed:

President's Address, W. E. Sweezy.

"Kansas Water Survey," Prof. F. O. Marvin.

"A Problem of the Country Light Plant," H. V. Forest.

"Composition of Natural Gas," Prof. E. H. S. Bailey.

"Developing a Day Load for Small Central Stations," C. L. Brown.

"Relation of Kansas University to the Electric Industry of Kansas," Prof. R. M. Freeman.

"The Future—What Shall It Be?" F. L. Williamson.

"Profitable Co-operation," J. Robert Crouse.

The place of next meeting will be Topeka, Kan., and the date, October 16, 1907.

Several new members, central station managers, were added to the list of members.

The president and the assistant secretary expect to do some energetic work in the Wrinkle Department, and have a good question box at the next meet'ng.

The meeting was considered the best of the Kansas association, and the officers look forward to a bright future for another year.

J. D. NICHOLSON, Secretary,
Newton, Kan.

THE CORPORATION AND THE PUBLIC.*

(By Edward P. Hulse.)

The present seems to be the day of publicity concerning the inner workings of all great businesses. What the cause may be need not be discussed here, but the public is certainly abroad with the interrogation point, and those corporations whose business is large enough to be classed as of a semi-public nature are the ones most likely to feel the effect. Nothing seems now too severe to be asserted by the yellow press—and believed by the public—against a corporation and those connected personally with its management. How can this sentiment be overcome by the railway companies? Can it be negatived?

There is a remedy—a remedy in the experience of those who have tried it that is easy; and the conservatism of large operations need not be compromised thereby. This is a plea for that method; and specific instances will be cited. Street railway lines pay dearly for not letting the traveling public know more about the business where it touches them, and the reasons back of all "rules and regulations;" they pay for it in good dollars in a business where the unit is a nickel. I did not use the trite phrase "take the public into their confidence," for that is not what I mean. I do not believe in too much of the "open-mouth" policy; but I have found that it pays to transmit to the public an understanding of street railway operation, and of the principles back of it, insofar as it concerns the public. I said "pays" with full knowledge of the weight of the world. All street railway men know how unfriendliness on the part of the public has a direct effect on the tangible property of a street railway company. Plush seats are cut open, rattan seats are split with a knife, heels ground into fine finish, curtains ripped out, sash springs broken, the least want of repair or the hard working of a door is enough to warrant the public in smashing it. These repairs count up. The uniformed employes of some roads are treated by the public so unfairly, even contemptuously, that it is difficult for these roads to get good men, and in some cities the companies have to accept foreigners who can hardly speak the language. Then from the traffic agent's point of view friendliness is the greatest asset, and he spends the money appropriated to Account 31 in cultivating it, for he knows that "good will is gain." Street railway managers in particular become calloused to what the public thinks of the lines. "Road managers become so interested in the details of operation that they are too prone to concentrate all their attention on what might be termed the mere 'mechanism' of public service. They would rather have the praise of another railway official to the effect that they were operating a fine road than to know what the public was thinking about it."

They become so used to the continual petty complaints, when they know that they are giving on the whole a good service, that they refuse even those answers that might be educative. Regulations are posted and the traveling public

*From the Street Railway Journal

is expected to conform to them. How readily they would do so if they knew the reason back of each one, and that they were all in the interest of the passengers' safety or their more speedy transportation. Many roads have tested the advisability of a regular educational pamphlet, and find its results in fewer accidents, a better understanding of the rules, quicker handling of crowds, and distinctly better relations; and this counts in a business so dependent on the good opinion of the public. The hard-headed manager may profess to care very little for public opinion and the newspapers, but in the end he will have to pull down his flag. It is through the news columns of the papers in the territory served by his road that the public gets the information by which it forms its opinions; and favorable public opinion is the most effective form of advertising that tends to increase both business and pleasure travel. I will give some specific instances in point.

A high-tension line supplying one division of a large interurban road was down, through no fault of inspection or lack of supervision, and the return of several hundred Sunday school picnickers was delayed thereby until long after dark. The general manager had his coat off, and was doing everything that mortal man can do over telephone lines to locate the trouble or borrow power to move the cars. The reporter for the most influential morning paper came around. Ten words would have given him enough for an article that might at least have stated, along with the inevitable facts, something favorable for the company that would tend to hold the confidence of the public in the road's ability to maintain schedules. However, the general manager's distress vented itself against the newspaper man, and so this is part of next morning's article:

"It was almost impossible to learn anything regarding the trouble or its results, as the officers of the company refused to say a word for publication. General Manager Blank assumed an air of the strictest reticence, giving the impression that the road had had troubles enough of its own of late, he attributing most of them to the newspapers. He declared that he would not tell the reporter a 'G—— d—— thing.' It was not until the parents of the children who were storm-bound began to pour forth their murmurs of discontent that it was, etc."

This incident has stuck to that general manager, and he has heard of it constantly for three years. It has cost his road the business of many church, Sunday school and secret society outings and the letting of many special cars. The president saw it, and established an "information bureau" where the public through the newspapers could be treated from a business standpoint. When some street railway men do consent to talk for the papers it would be better for the company's dollars had they been muzzled entirely.

Through a newspaper in a large Southern city the editor, bearing a name known the country over, was rasping the local road every day, finally attacking the management, and then individually by name. A friend of both arranged a bloodless meeting where the editor and the general manager became acquainted. The newspaper man found that the street railway man was sincere, and that there was an absolute business necessity for tearing up certain tracks and putting down others, following a consolidation of two lines, with the ultimate result of bettering the service and improving the schedules. The official gave a few good reasons for everything that was done, without telling any more than the public he served had a right to be interested in and to know, and the attacks ceased. And there wasn't any pass at the bottom of it.

Another instance is in the case of an interurban road, the manager of which had publicly expressed his disdain of the effect of newspaper attacks, saying that the "conservative public" knew enough not to pay any attention to them and that the "thinking part of the community" would know that the company had its side, and that therefore it was not necessary to state it. Matters finally got so strained that it took one man's time visiting the forty newspapers along the line business managements in the interest of regaining public conbusiness managements in the interest of reagining public confidence and showing that the company's effort was to adapt its service to the needs of the greatest number. The traffic receipts began immediately to show the direct result of this change of policy, and the paid advertising columns had no part in it. The system is now one of the most popular in the country, and the people along it refer to it with pride, and do everything they can to expedite a service that they have learned to know is good. They became convinced—despite certain editorials advising them to take their time getting on ceipts"—that the very rapid transit that they all desired was being hindered by such methods and that the requests to "step lively" and to "move up front" were in the interest of bettering the service and adding to the comfort of all the patrons.

Would not the thousand and one aggravating changes rung on the phrases "stealing franchises," "taking up the city's streets," etc., cease in great measure if the public was schooled to recognize the simple fact that in every great collection of human beings into what is called a city, spaces between the houses known as streets are set apart so that the population may move to different parts of it? On each side of this thoroughfare a small sidewalk is reserved for those who do not care to go with haste and who prefer to walk. The larger central part is for transportation by vehicles of all kinds—bicycles, wagons and carriages, automobiles, etc. Everyone does not have a carriage for rapid transportation and could not afford its maintenance. Cab service supplies to a great extent this need, but the charge is proportionally very high. A company agrees to carry the public for a small price, but to do so it must have the use of the public's streets. If it had to secure a private right of way through a city, buying up property on which to build a road, the public would not have cheap transportation. It would cost 50 to 75 cents a mile to carry them at the same speed. Who uses the streets? The public. To whose advantage, outside of a proper financial return that any business is entitled to, are these street railways operated? The public's. Do street railway investments pay the enormous sums alleged? Census figures and other statistics easily available show that they do not, and that many pass their dividends. Who takes no chances on the investment and—profit or no profit—is the unfailing gainer? The public.

This card house of antagonistic sentiment, which has been erected over the silence of street railway managemnts who let impractical theorists do all the talking, would fall at the first breeze of a fair expression of the rights and principles. Politics, of course, influences many papers in their attitude, and their friendship could never be gained; but if the public had a few of these basic facts drilled into them, such frothy fulminations would have no effect.

If the people, step by step, get the opinion that they are being "robbed of their streets," that fares are too high, that transfers should hang on every tree, that conductors are tyrannical, that they are being "hustled" when requested not to block a doorway, that they will gain something somehow by stepping off a car like chickens coming out of a hen-honse in the morning and stopping one by one to look at the sun, that they should avoid paying fares, that cars have no right on the rails they run on, that motormen should be "dared" to run over them, who is to blame? If juries can only see one side to a damage suit, as between corporation and individual, regardless of facts, then the "conservative" management—and not the editor who builds up his circulation by catering to public sentiment—is to blame. And don't forget that it costs dollars.

The JOURNAL OF ELECTRICITY POWER AND GAS
WITH WHICH IS INCORPORATED The Engineers' Architects' and Builders' News

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EDITORIAL.

INTERURBAN ELECTRIC RAILWAYS

The interurban electric railway has proved a great success in the East. This is probably particularly true of the electric railways of Indiana and Ohio. While the lines are not as extensive in Southern California, yet the success of the Huntington system of electric roads between Los Angeles and adjacent cities has been very pronounced. The construction of electric railways in the eastern part of the United States seems to be on the point of duplication in Central and Northern California. The Central California Traction Company's lines of Stockton have been in operation for some time. A similar road between Oroville and Chico, known as the Northern California Traction Company's system, has also been in operation for nearly a year and has been a decided financial success, and is now being extended to Marysville. One of the best constructed and equipped electric railways in the East or West will be that of the Ocean Shore Railway Company between San Francisco and Santa Cruz. Work upon this system has been actively prosecuted during the past year and a half, and probably within a year service upon the proposed scenic line will be begun.

The field of the electric railway upon the Pacific Coast seems large and the opportunities very attractive. For the most part, such service will probably preferably be in individual car service. With the exception of the Key Route, or San Francisco, Oakland & San Jose Railway system, between San Francisco and Alameda county, all the electric railways on the Pacific Coast are operated with individual motor cars. In this instance, the electric train is made necessary on account of the ferry trip across the Bay, each ferry boat landing a large number of passengers on the east side of the Bay at once, therefore, requiring not only one train, but three or four trains to complete the trip.

For interurban service there seems no system equal to that of the electrically propelled cars. The gasoline motor car has given excellent satisfaction, particularly on branch lines of long established steam railway systems. The gasoline motor car may in time displace the electrically operated car, but up to the present time this does not seem probable except in rare instances.

There has been much discussion in the past as to how soon the steam locomotive will be supplanted by the electric motor. During the last ten years, while it may be true that electric street railway systems have in many cases replaced local steam roads, yet the question really is to decide in each case as to the adaptability of the steam and electric train. For long distances and through traffic, the electric railway system has yet failed to give service equal to the steam roads. For the shorter branch lines, however, there can be no question as to the fitness of the electric railway system. This attitude of the steam railway men does not seem antagonistic toward the interurban electric systems. The electric lines in Los Angeles and vicinity have, of course, worked to the detriment of many branch lines of the steam railway system, but the general effect has been to materially increase the traffic, not only for the electric railways, but for the through lines of the steam roads as well.

REGULATION OF LONG DISTANCE TRANSMISSION SYSTEMS.

Equal in importance, from an engineering standpoint, to the securing of proper insulators for long distance high voltage transmission systems is the proper regulation of the voltage at the different points of consumption of power in such systems. The mechanical details of pole line construction, as well as the design and construction of extremely high voltage transformers, have been definitely established by the experience of engineers during the past five years. In line construction, undoubtedly the Pacific Coast has done much pioneer work, but we in the West have been most ably supported by the manufacturers and engineers in the East, who have improved the construction of high voltage transformers, as well as the very reliable high tension insulators now manufactured.

For direct current transmission the drop in voltage in the line is always equal in percent to the energy lost in transmission in per cent. In alternating current transmission systems, however, this is very seldom the case. The loss of energy in transmission is generally assumed to not exceed 10 per cent. In three-phase transmission, if the loss of energy is 10 per cent, the variation of voltage from no load to full load with unity power factor will be greater than 10 per cent unless the voltage of transmission is sufficiently high and the distance of transmission long enough to introduce an appreciable capacity effect in the line which tends to

counteract the inductive effect of the line and the induction motors in operation on the system.

In the long distance transmission systems on the Pacific Coast the great number of sub-stations for distribution from the transmission lines renders it impossible to deliver to each of such sub-stations the proper voltage at all loads. In such systems the synchronous motor as a part of a motor generator set is of great value in properly regulating the voltage. By over-exciting the synchronous motor it is possible to regulate the voltage in the various sub-stations through a wide range. There is, of course, a limit to such regulation on account of the capacity of the synchronous motor. It must be also borne in mind that it is extremely difficult to provide such regulation of voltage when the synchronous motors are in addition called upon to deliver their full rated mechanical output.

Feeder regulators for each individual sub-station are very necessary for good service on the distribution system. The operation of many such sub-stations on a single transmission line increases the necessity of regulators for the control of individual feeders radiating from each sub-station. The flexibility of such feeder regulators adds much to their value. One feeder may serve a power district while another from the same set of step-down transformers may be used to serve a business or residence district for lights only. Also since the range of operation in such regulators depends upon the magnitude of the load and since the maximum demand often occurs at different intervals during the day with different feeders, the regulation of the voltage of the individual feeder is essential if good service is to be obtained.

It is often of considerable advantage if each sub-station transformer is provided with a large number of taps on the low tension coils, allowing a variation in voltage on the low tension side of from 5 to 20 per cent above and below the normal. These connections are usually, however, made solid, and it is best to connect up the step-down transformers in this way or the hand regulation of the transformer will affect all feeders to practically the same extent.

The automatic voltage regulator, such as the Tirril, is almost indispensable for long distance water power transmission systems where the load is subject to sudden and large variation. The combination of the Tirril regulator in the generating station and the individual feeder regulator for the sub-station and distribution systems gives the most satisfactory results. Where the condenser effect or the capacity of the line is sufficiently large to cause an appreciable charging current, the difficulty of properly regulating the voltage is often as great at light loads as with very large loads. The use of large induction motors requiring excessive lagging current in such long distance, high voltage systems tends to improve the regulation of voltage, the inductive current balancing to some extent the leading or charging current of the line.

There are so many variables in the power demand from a transmission system that the close regulation of voltage is often accomplished with considerable difficulty. Not only does the load vary greatly in magnitude in a small period of time, but the power factor is also subject to large fluctuations. The success of long distance power transmission is very largely due to the skill with which voltage regulation has been carried out, not only in the generating station with the automatic voltage regulators, but in the sub-station with individual feeder regulators.

BOOK REVIEWS.

Practical Alternating Currents and Power Transmission. By Newton Harrison, E. E. 375 pp., 172 illustrations. W. L. Hedenberg Publishing Co., New York.

In this book the author set for himself the task of presenting the principles and pratcice of alternating currents without the aid of mathematics. While it is true that the student of engineering seeking elucidation on some particular point is often frightened away by the pages of complex equations which confront him, it is doubtful if a satisfactory book on lighting and power transmission can be written without at least giving the formulae commonly used in practice. The author apparently deems it sufficient to show the character of desired computations by arithmetical examples, which occur frequently. This book contains many of the facts of alternating currents applied to lighting and power transmission, and diagrams showing the constructive principles of alternators and transformers. To those already somewhat familiar with the theory of alternating currents this book may offer some interesting reading.

TRADE CATALOGUES.

The Risdon Iron & Locomotive Works, San Francisco, have just issued the first two of a series of bulletins which they intend to publish on their line of smelting equipment. Bulletin No. 19-1 is devoted to silver-lead blast furnaces, and Bulletin No. 19-2 to copper blast furnaces. Both are artistically arranged and each shows a sectional elevation of the furnace described.

The H. W. Johns-Manville Co., 217-231 Clybourn street Milwaukee, Wis., has just issued a flyer which calls attention to the various types of electric car heaters which that company manufactures. A folder, also issued by the same company, tells how to pack gas engine cylinder heads with "Mobilene," a new packing, which is also a product of the works.

Catalogue "A" of the Pacific Electric & Mfg. Co., 1161 Howard street, San Francisco, is a 27-page well-illustrated book devoted to oil and air brake switches. These are made in sizes for use on long distance transmission lines of from 10 to 100 kilovolts. Several cuts show the arrangement and housing of the switches.

The issue of October 13th of the Street Railway Journal, which is one of the special issues which appear every year at the time of the annual meeting of the American Street and Railway Association, is representative of what a handsomely gotten out technical journal can be. Aside from its excellent typographical features, it is particularly worthy of note editorially, since the major part of the reading pages is given over to a resume of interurban railway practice in the Middle West.

There are 42 pages of half tones, showing construction and equipment of a number of these interurban roads, together with views and maps of Columbus, Ohio, where the convention was held.

FAREWELL BANQUET GIVEN IN HONOR OF MR. E. L. WAYMAN OF THE CALIFORNIA ELECTRICAL WORKS, SAN FRANCISCO.

"Fifteen men on a dead man's chest,
Sing Yo Ho, Ho, and a bottle of rum."

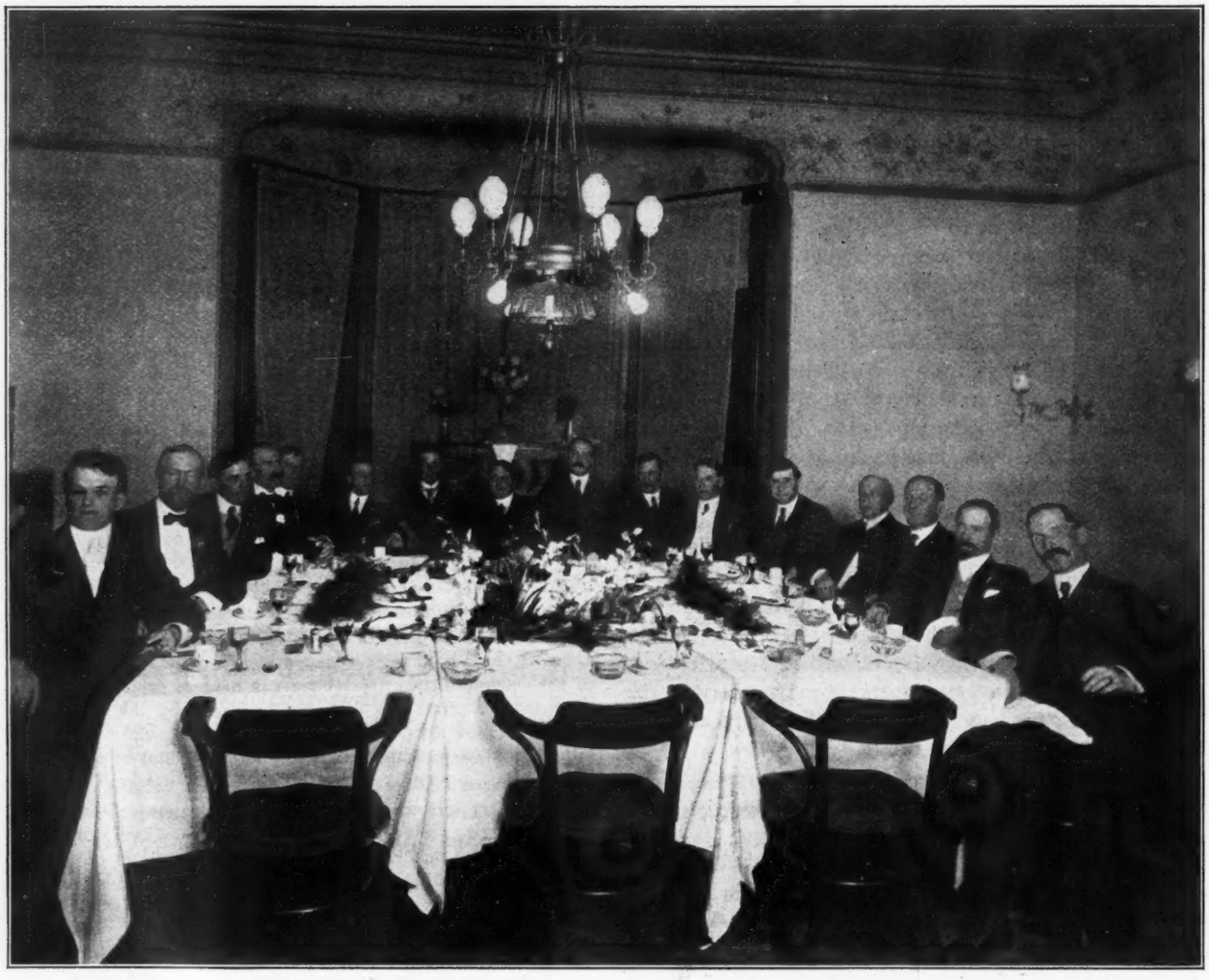
It was not a dead man's chest, nor was it a bottle of rum, but fifteen electrical men around a flower-bedecked banquet table at the Techau Tavern on the evening of the 23d of October, assembled in honor of one of the brightest and most valued members of the electrical fraternity, who is about to leave San Francisco for newer and possibly brighter fields.

In the few short years that Mr. Wayman has been identified with the electrical interests on the Coast he has, through his broad and honest dealings, together with his genial personality, endeared himself to the fraternity as but few men are able to do in a lifetime. It is with sincere regret on his part that he is leaving a concern in which he was in no way a small factor in the success they have made. But when the temptation to do for himself what he has always done for others, and enter a business in which he held a proprietory interest was offered, he did, as he has always done, the right thing, accepted it. In his new field his many friends wish him that success that he so justly deserves.

Mr. Wayman is going to Detroit, Mich., to take the management of a new industry, the manufacturing of household utilities from pressed steel.

Mr. T. E. Bibbins acted as toastmaster, and by his bright and witty sayings kept the flow of nature's spirit to the highest ebb, while the excellent attendants did their part in keeping the flow of champagne at the same level. There were speeches made by each and every one present, and then some more. Were it not that the "Journal" was sworn to secrecy, many of the good sayings and bright and witty speeches would be recorded. We will simply say that lightning in its natural state, nor since it has been harnessed by man, never traveled at a more rapid gait than the fun did that evening. The music by Professor Heller was exquisite, and the singing by Mr. Frank Fowden, President Scribner, Dr. Thaxter and W. B. F. P. Goodwin made a great hit.

Near the close of the evening Mr. A. H. Elliott, after telling a few good stories, settled down into the serious part of the evening. He delivered one of the most able farewell speeches the writer has ever had the pleasure of listening to, and at the close presented Mr. Wayman with a beautiful locket set with diamonds and emeralds, on the back of which the initials of every one present were engraved. Mr. Wayman was visibly affected, but in a few happily chosen words expressed his thanks to all for the pleasure they had given him. His hearty invitation to not only those present, but each and every one of his many friends on the Coast, to never pass him by if they were in the neighborhood of Detroit, showed the spirit that has made him so popular here on the Coast.



E. L. Wayman, California Electrical Works
H. C. Thaxter, Standard Electrical Works
Frank Fowden, Brooks-Follis Co.
W. L. Goodwin, Century-Klein Co.
T. E. Bibbins, General Electric Co.
R. J. Davis, Standard Electrical Works
George A. Cole, John R. Cole Co.
A. H. Elliott, Secretary Jobbers' Ass'n
C. C. Hillis, Electric Appliance Co.
C. E. Wiggin, California Electrical Works
E. M. Scribner, California Electrical Works
A. M. Funke, California Electrical Works
John R. Cole, John R. Cole Co,
E. B. Strong, Journal Electricity Pub. Co.
F. E. Corwin, Bryant Electric Co.

SOME REQUIREMENTS OF CARBURETER DESIGN.

In a paper read before the Society of Automobile Engineers, Mr. E. T. Birdsall, M. L., said that ever since the idea of using a vaporized or gasified liquid fuel in the internal-combustion engine was suggested, the device for preparing the fuel for use in the engine has been a subject for much thought and study. Numberless designers more or less insufficinently armed with the proper experience, knowledge and data for the task, have undertaken to solve the problem with varying results. As long as the principal requirement was to furnish fuel to engines working under a practically constant load and speed, and fuel was cheap, the defects of the early carbureters were not such as to interfere seriously with the operation of the engine. Other troubles, such, for example, as ignition, occupied so much of the operator's time, that the carbureter, so long as it worked at all, was neglected.

In following remarks it is assumed that the engine used has a sufficient number of cylinders to produce a steady flow of mixture and that the carbureter is of the modern float-feed type, with a fuel jet and main and auxiliary air inlets. The fuel is assumed to be gasoline, although in the main alcohol or heavier oils require the same general conditions. The object to be attained is a mixture that will develop a maximum of power from a given size of motor with a minimum of fuel, not an average of "good-enough" result.

With the use of the internal-combustion engine under extreme variations of load and speed, as demanded by the modern automobile, with the perfection of the ignition and other features, and with the rapid rise in price of the lighter oils, the subject of carbureter design becomes one of great interest and importance. Again, in a few years, when the commercial wagon will demand a low fuel cost combined with great certainty and flexibility of engine operation, the carbureter will probably determine the extent of the development of this, the most important branch of the automobile industry.

The function of a carbureter is to supply the proper mixture of air and fuel to the engine, under all conditions of speed and power. The four essential conditions under which carbureters must work are:

First—Wide-open throttle and high engine speed, as when climbing hills or running fast on the level.

Second—Wide-open throttle and slow engine speed, as when traveling slowly on the high gear or picking up from standstill.

Third—Partly closed throttle and high engine speed, as when running fast down grade or on a low gear.

Fourth—Nearly closed throttle and low engine speed, as with engine running idle when car is standing.

For some time it was thought that the best carbureter was one that gave a constant mixture under all conditions. But we now know that a constant mixture is not the best from either the standpoint of best operation or full economy. It was also thought that the best mixture contained just sufficient oxygen to entirely consume the carbon and hydrogen. It was found, however, that a mixture with a slight excess of fuel gave the best results. These facts being demonstrated, it becomes almost obvious that the different engine speeds will demand different mixtures for maximum results. Thus at low speeds, the mixture should be richer than at high. This is due to the fact that at low speeds more heat is lost to the cylinder walls, more compression pressure is lost by leakage, and the combustion can therefore be slower, thus sustaining the pressure. At high speeds the compression is higher, due to less leakage and less loss of heat. Therefore unless the mixture was leaner at high speed there might be danger of pre-ignition. A lean and highly compressed charge also burns faster and hence gives better pressures and fuel economy than a richer one.

The quantity of mixture that an engine will take varies greatly with the speed. At slow speeds the quantity is equal to the cubic contents of the cylinders multiplied by the number of power strokes. At high speeds of 1,000 revolutions and over, the quality may drop to less than one-half the theoretical amount, depending on the design of the valves, inlet piping and carbureter passages. This peculiarity reacts upon the compression and hence on the mixture desired for best results. It will thus be seen that the design of the engine has a great deal to do with the carbureter design, which explains the well-known but seemingly mysterious fact that a carbureter that gives good results on one engine fails to maintain its reputation when applied to one of different design.

The design and class of ignition used have also a marked influence. Poorer mixtures can be used as the spark is hotter, the throttle can be more nearly closed, resulting in increasing engine capacity and fuel economy.

To get the maximum power out of a given sized engine the fuel should be introduced into the cylinders as cold as possible consistent with complete evaporation, intimacy of mixture and completeness of combustion. To provide for the heat absorbed by the evaporation of the fuel, hot air is drawn in to form the mixture, the entire apparatus is heated by means of hot water or the general heat of the engine compartment under a closed bonnet is relied upon. The adjustment of this heat is an important matter, but exact knowledge on the subject is apparently non-existent.

The ever-varying density and compositions of the fuels used and obtainable introduce many and very serious complications into the problem. These differences demand different sizes of jets, different float levels, different amounts of heat to be supplied, and different proportions of air for combustion.

Different densities and temperatures of the fuel affect to a very appreciable extent the flow of the fuel from the jet. Between extremes this has been found to vary as much as 40 per cent. Thus a carbureter exposed to atmospheric temperatures in this latitude would seem to require a wide range of adjustment.

Owing to the absence of a ready means—like the pressure gauge on the water circulation, or the voltmeter on the accumulators—of ascertaining the quality of the mixture being delivered by a carbureter, the majority of the motors in use are operating under more or less disadvantageous conditions, even if carefully and properly regulated at the outset.

The amount of reliable data and facts concerning the action of air and gasoline in a carbureter at the command of designers and students is remarkably small. Of no other part of the automobile is so little known. What is badly needed is a series of carefully planned and exhaustive experiments with data so arranged that it can be analyzed and deductions made.

TRADE CATALOGUES.

The Wellman-Seaver-Morgan Co., Cleveland, Ohio, call attention to their practice as consulting engineers and designers for general work by their catalogue "Section A," which contains many illustrations showing some of the more important work performed in the past.

General Electric Co.'s recent publications:

Bulletin No. 9143, devoted to type "H" transformers.

Bulletin No. 4,456, giving dimensions of wrought copper cable terminals.

Bulletin No. 4,457, giving parts of form "B" arc headlight.

Bulletin No. 4,459, describing feeder regulators.

Bulletin No. 4,460, giving parts of form "3" arc lamp.

Bulletin No. 4,461, describing G. E.-78 railway motor.

Bulletin No. 4,462, devoted to variable speed direct current motors.

Bulletin No. 4,463, describing carrier bus arc panels.

Bulletin No. 4,464, devoted to polyphase induction motors.

STANDARD SYMBOLS FOR WIRING PLANS.

The speedy and economical execution of a particular piece of work is too often prevented by the failure of a workman to correctly interpret the instructions on a drawing. This is due, not so much to the lack of intelligence on the part of the workman, but because symbols and abbreviations are used whose meanings he does not know. Frequently he resorts to a guess, and guesses wrongly.

There is no reason why the symbols of a graphical language should not be standardized as well as the words of our common language. In this respect the action of the National Electrical Contractors' Association, at its annual meeting in July, in adopting standard symbols for wiring plans, is a much-needed step which should receive the hearty support of every engineer and architect.

The symbols, which are here given, were carefully selected from a great many submitted by prominent engineers and architects from all over the country, and were chosen with an eye to simplicity and ease of execution. As far as possible the association adopted those symbols which are already in common use.

The following suggestions accompany the table of symbols: Indicate on plan or describe in specifications the height of all outlets located on side walls. It is important that ample space be allowed for the installation of mains, feeders, branches and distribution panels. It is desirable that a key to the symbols used accompany all plans. If mains, feeders, branches and distribution panels are shown on the plans, it is desirable that they be designated by letters or numbers.

The National Contractors' Association is extremely anxious to have these symbols come into general use, and will mail copies to those interested on application to Mr. W. H. Morton, secretary, 94 Genesee street, Utica, N. Y.

STANDARD SYMBOLS FOR WIRING PLANS

AS ADOPTED AND RECOMMENDED BY THE NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES

Ceiling Outlet; Electric only. Numeral in center indicates number of standard 16 C. P. Incandescent Lamps.

Ceiling Outlet; Combination. $\frac{4}{2}$ indicates 4-16 C. P. Standard Incandescent Lamps and 2 Gas Burners.

Bracket Outlet; Electric only. Numeral in center indicates number of Standard 16 C. P. Incandescent Lamps.

Bracket Outlet; Combination $\frac{4}{2}$ indicates 4-16 C. P. Standard Incandescent Lamps and 2 Gas Burners.

Wall or Baseboard Receptacle Outlet. Numeral in center indicates number of Standard 16 C. P. Incandescent Lamps.

Floor Outlet. Numeral in center indicates number of Standard 16 C. P. Incandescent Lamps.

Outlet for Outdoor Standard or Pedestal; Electric only. Numeral indicates number of Stand. 16 C. P. Incan. Lamps.

Outlet for Outdoor Standard or Pedestal; Combination. $\frac{6}{6}$ indicates 6-16 C. P. Stand. Incan. Lamps; 6 Gas Burners.

Drop Cord Outlet.

One Light Outlet, for Lamp Receptacle.

Arc Lamp Outlet.

Special Outlet, for Lighting, Heating and Power Current, as described in Specifications.

Ceiling Fan Outlet.

S, P. Switch Outlet.

S^2 D. P. Switch Outlet.

S^3 3-Way Switch Outlet.

S^4 4-Way Switch Outlet.

S^a Automatic Door Switch Outlet.

S^e Electrolier Switch Outlet.

} Show as many Symbols as there are Switches. Or in case of a very large group of Switches, indicate number of Switches by a Roman numeral, thus: S XII; meaning 12 Single Pole Switches. Describe Type of Switch in Specifications, that is, Flush or Surface Push Button on Snap.

Meter Outlet.

Distribution Panel.

Junction or Pull Box.

Motor Outlet; Numeral in center indicates Horse Power.

Motor Control Outlet.

Transformer.

Main or Feeder run concealed under Floor.

Main or Feeder run concealed under Floor above.

Main or Feeder run exposed.

Branch Circuit run concealed under Floor.

Branch Circuit run concealed under Floor above.

Branch Circuit run exposed.

Pole Line.

Riser.

Telephone Outlet; Private Service.

Telephone Outlet; Public Service.

Bell Outlet.

Buzzer Outlet.

Push Button Outlet; Numeral indicates number of Pushes.

Annunciator; Numeral indicates number of Points.

Speaking Tube.

Watchman Clock Outlet.

Watchman Station Outlet.

Master Time Clock Outlet.

Secondary Time Clock Outlet.

Door Opener.

Special Outlet; for Signal Systems, as described in Specifications.

Battery Outlet.

Circuit for Clock, Telephone, Bell or other Service, run under Floor above concealed. Kind of Service wanted ascertained by Symbol to which line connects.

Circuit for Clock, Telephone, Bell or other Service, run under Floor, concealed. Kind of Service wanted ascertained by Symbol to which line connects.

NOTE—If other than Standard 16 C. P. Incandescent Lamps are desired, Specifications should describe Capacity of Lamp to be used.

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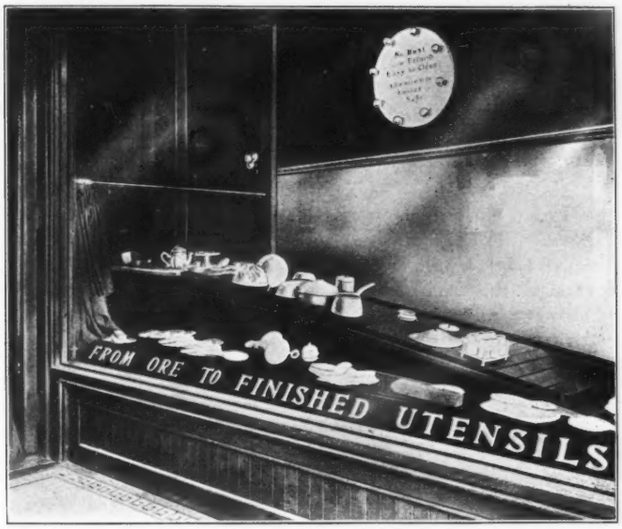
INDUSTRIAL

A TRAVELING WINDOW.

In the field of advertising and display, it might seem that up-to-date merchants had exhausted the possibilities in the way of electric signs, etc. It remained, however, for an ingenious and enterprising Cleveland merchant to discover a way of multiplying his available display space by four—a seeming impossibility.

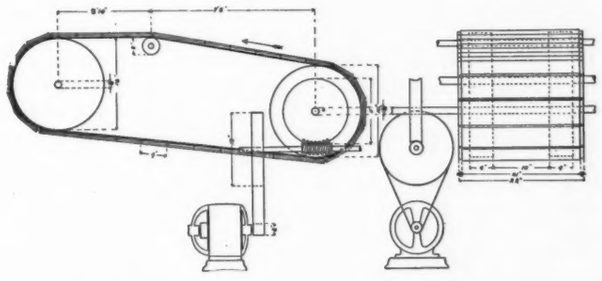
This is how he did it.



The window floor was arranged so that it revolved like an endless chain over two drums at either end; the window floor extending back into the store the depth of the window and being separated by a black velvet cloth.

The diffrent aluminum articles—some 200 in number—were wired to the moving window floor, and thus produced such a unique and striking effect as to challenge the attention of large numbers of pedestrians.

This enterprising merchant has "blazed a new trail" in the window display line which merchants in many other lines of



business may find it to their advantage to employ.

The device was home-made, simple in design, inexpensive, and driven by a small electric motor concealed below the floor.

The accompanying photographs, secured under adverse reflecting conditions, show the general appearance of this novel arrangement.

The detailed sketches show accurately the mechanism.

THE PLANT OR THE MERCHANTS' HEAT, LIGHT & POWER CO, CANTON, OHIO.

The utilization of exhaust steam for heating purposes has been successfully accomplished by the Merchants' Heat, Light & Power Co. at Canton, Ohio.

Within the past five months this company has constructed a system under the central portion of the city and has obtained a franchise for an additional five miles of street. The heating system was designed for 250,000 square feet of radiating surface, with provision for increasing to 500,000. At the present time the connected heating surface is 100,000 square feet. The charge for heating is 31½ cents per square foot of radiating surface for seven months, or 60 cents on the basis of 1,000 pounds of water by condensation.

Steam is supplied by three 250 horsepower Sterling water tube boilers fitted with Roney stokers and arranged in a battery and a half with provision for an additional unit. The engine equipment consists of two Russell cross-compound non-condensing engines, each of 375 horsepower, capacity at 200 revolutions. Each engine is direct connected to a 250-kilowatt 2-phase 2,300-volt National alternator made by the National Brake & Electric Co., Milwaukee. These machines carry the entire lighting load, which is at present about 72 amperes. These alternators are of modern design, and are especially built for close regulation and large overloads.

SOMETHING ABOUT INCANDESCENT LAMPS.

One of the hardest utilities for a property manager or purchasing agent to buy is incandescent lamps. So many lamps are now on the market, all claiming to be "better" or "as good as" any other make that it is not easy to decide where to place the order and to whom to give the preference. There are ways of testing lamps, of course, but these are usually beyond the average manager, especially if his property be not especially large, and besides samples submitted for test may vary from the average and be either better or poorer without any conscious fault on the part of the manufacturer. The only sure way to get a satisfactory lamp is to buy from some responsible company and keep track of all the lamps sent out if possible.

The Sunbeam lamp has been on the market for 18 years and has stood the test of time. It was one of the first successful lamps produced, and has been sold in ever-increasing numbers since its first introduction. It has never been known as a cheap lamp, nor is it any more costly than the others, but its manufacturers claim that it is "the lamp of quality," combining all the good features that a lamp should have with a low current consumption. It is made suitable for all circuits. Having been on the market so long it is to be presumed that the lamp has made a great many friends who declare without hesitation that it is the best that can be bought. It is now in use in some of the largest plants in the country, and in great numbers of buildings where excellence of lighting is a prime requisite.

A postal card to the California Electrical Works will bring their literature and proposition, and the progressive man, who is always looking for the best thing there is, will find it worth while to see what these people have to offer.

News Notes.

TELEPHONE AND TELEGRAPH.

Point Richmond, Cal.—The Pacific States Tel. & Tel. Co. will erect a two-story building, of brick, on Third street, to cost $5,000.

Reno, Nev.—R. T. Roy, F. R. Lamb and others are interested in a project to establish a telephone and telegraph system for the various camps in Churchill county. It is proposed to connect Wonder, Fairview, Stillwater, Fallon and Eastgate by the way of Hazen or Lovelock. The company that owns the line running from Fallon to Fairview announces it will build up Wonder and other camps, and it may be able to forestall the new system and prevent the organization of the other company.

Grass Valley, Cal.—The people of Wolfe district will meet at Forest Springs soon to discuss the proposition of building a telephone line to connect with Grass Valley circuit. A representative of the Sunset Co. is here looking into it.

Vallejo, Cal.—The cruiser Charleston is fitted with a Schumacher wireless outfit, and connection was recently made with Mare Island from Magdalena Bay, 990 miles from the navy yard, when the Charleston announced her arrival there. This is one of the longest distances yet caught by wireless at the navy yard.

Bellingham, Wash.—The Sunset Tel. Co. has closed contracts with 20 additional ranchers on the Everson and Goshen road near Wahl.

Columbus, Mont.—The Absarokee Tel. Co. has been organized. Ed. Backer, president. The line will extend from the Madison ranch to Absarokee.

Ellensburg, Wash.—The North Kittitas Rural Tel. Co. has applied for a franchise to construct and maintain a telephone line along certain county roads.

New Westminster, B. C.—Work has been commenced on the new Grand Trunk Pacific telegraph system near Portage La Prairie.

North Bend, Ore.—A wireless telegraph station will be installed in this city by the Pacific Wireless Tel. Co. at a cost of $2,000.

North Yakima, Wash.—The Pacific States Tel. & Tel. Co. has commenced the work of placing its wires underground in the fire limits.

Olympia, Wash.—B. F. Hall and others have formed a company to construct and maintain another rural telephone line along the county road to a point near Lacey.

Spokane, Wash.—The Interstate Tel. Co. has increased its capital stock from $20,000 to $100,000.

ILLUMINATION.

San Francisco, Cal.—Acting Mayor Gallagher states that he will urgently recommend to the lighting company that arc lights be established throughout the entire burned district at the earliest practicable date. The merchants along Van Ness avenue have agreed to place ornamental poles up the length of Van Ness from Market to Washington, and in behalf of the city the mayor has agreed to furnish power to an amount equivalent to the amount invested by the merchants for poles and lamps. The project of lighting the avenue is to be pushed to an immediate conclusion. In the matter of lighting Market street attention has been called to the fact that at the time the overhead franchise privilege was granted to the United Railroads the corporation agreed in part consideration for the franchise to light Market street at its own expense, placing arc lamps on the trolley poles at once, replacing them by permanent ornamental poles and arc lights as soon as possible.

Bisbee, Ariz.—At a special election to be held November 15th the people of Bisbee will vote whether or not a franchise will be granted to the International Gas & Light Co. permitting it to install and maintain a light and power system in the city.

Prescott, Ariz.—Sealed bids will be received by the mayor and the City Council until October 18th for work, materials and equipment to be used in the construction of a generating station and distributing system of a municipal electric lighting plant. The council reserves the right to reject any and all bids. All goods furnished must be first-class in every particular and must pass inspection of the general manager of the Prescott Municipal Electric Lighting Department.

Modesto, Cal.—The Modesto Gas, Coal & Coke Co. has purchased lands and is having an excavation dug for a gas holder which will be 60 feet in diameter and 22 feet deep. The holder will be completed by January 1, 1907. J. A. Cressey says that he will erect buildings and install a complete gas plant of large capacity on his new property. Extensive changes in the mains in sections of the town where pipes are small will also be made.

San Diego, Cal.—Manager Groesbeck of the Consolidated Gas & Electric Co. states the company is contemplating installing a new steam turbine engine with a capacity of 1,000 kilowatts. The engine and boilers which will go with it will cost about $100,000.

Seattle, Wash.—The Seattle Lighting Co. has filed with the Board of Public Works plans showing the general arrangements of the new gas plant to be erected on the south side of Lake Union. Plans also show the general arrangements for the warehouses, furnaces and stable. The location is between Eighth and Ninth avenues and Mercer and Republican streets. From this location large gas mains will extend around the east side of Lake Union and on the north shore of the lake, where the main gas manufactory is located.

TRANSMISSION.

Palo Alto, Cal.—The new concrete municipal power plant will not be constructed this fall. Only one bid was received. That was from E. A. Hettinger, who named $11,950 for the job, or $5,250 for the work exclusive of excavation and cement work. Those figures were far in excess to the amount available.

Ukiah, Cal.—The Snow Mountain Water & Power Co. has resumed work on its power plant. The reservoirs in Gravelly Valley will be commenced and power lines will be erected, power house built and giant electric dynamos installed.

Oxnard, Cal.—The Ventura County Power Co., which controls the gas, water and electricity of this county, is about to build a transmission line to Castaic, at which it will tap the Kern River line of the Edison Co. and from there distribute electricity for light and power throughout the entire county. A new battery of boilers and new engines has been ordered for the Oxnard plant. Extensive plans for irrigation on the company's lands have been completed. A system of ditches will be built to conduct the water from Ventura river. Plans have been completed for the building for the company at Fourth and B streets of brick, to contain the general manager's office, general offices, etc., also salesrooms. In the rear will be a warehouse. There is now on the way 200 miles of wire.

City of Mexico—Emilo Madrigal has petitioned the Department of Fomento for a concession to utilize waters from the River Lerma for motive power.

Yerington, Nev.—A contract has been closed between the Truckee River General Electric Co. and the Nevada-Douglas Copper Co. by which the former will extend its power line from Como to the Douglas property.

Salt Lake City.—O. H. Ensign has joined J. H. Quinton and Chief Engineer Swenson at the Strawberry tunnel and the three will make an examination of the ground and locate a

good site for an immense power house which will be erected in the spring.

Oroville, Cal.—The Western Power Co., which has invested heavily in Reno power and light propositions, is now engaged in the development of a large plant upon the sources of the Feather river near Oroville. The agents of the company have acquired a large acreage of land, and it is reported that in the next three years they will invest $5,500,000 in this locality. Scores of men are already in the field. President Viele has himself been in Oroville and over the country which the company has purchased.

San Diego, Cal.—H. E. Huntington, accompanied by several associates, made a trip of inspection to San Diego, and there are strong indications that he proposes to extend his lines to San Diego from Los Angeles. He has acquired water rights at San Lius Rey for electric power and purchased all the riparian rights on the river. It is reported he will acquire two small railway lines at San Diego and engage in opposition to the Spreckels lines.

Kingman, Ariz.—F. F. Monteverde and other directors of the Desert Power Co. have decided upon Kingman for their power plants and will break ground in 20 days. The plant will take over 20 acres. Work of sinking a well for water will begin at once. It is the intention to furnish water, power and light to Kingman, besides power and light for the mining camps.

Colton, Cal.—J. H. Campbell will erect a power plant at the corner of G and Tenth streets.

TRANSPORTATION.

Los Angeles, Cal.—The application of the Pasadena, Verdugo & San Fernando Valley R. R. Co. for a 50-year franchise for a railroad through a portion of Griffith Park has come before the City Council.

Napa, Cal.—The directors of the Vallejo, Benicia & Napa Valley Electric Railroad have awarded the contract for grading for the proposed extension of the line from Union station to St. Helena to George Errington of Napa. Errington has commenced work on the road and will rush work as rapidly as possible. He expects to have the grading complete in the next three months. The total excavating will be 62,000 cubic yards. A camp for the workers employed on the road has been pitched at Union station.

San Luis Obispo, Cal.—The supervisors have passed a resolution granting L. J. Beckett a franchise for an electric railroad, electric telegraph and telephone systems. Sealed bids will be received up to November 7th.

Los Angeles, Cal.—An attempt was made to wreck a car on the Los Angeles Pacific Railway at 1 o'clock on the morning of October 15th on the line between this city and Venice. Advices from Santa Monica state that two men have been arrested on suspicion and that they have expressed a willingness to confess to the plot to wreck the car for the purpose of robbery, and have implicated four other men. A 4x4 piece of timber was placed across the rails, and but for the watchfulness of the motorman a dangerous wreck would have occurred. The motorman succeeded in bringing the car to a stop a few feet from the obstruction.

San Francisco, Cal.—At a meeting of the board of arbitration to which the existing differences between the United Railroads and its employes have been referred, held Saturday, it was unanimously decided that the next meeting of the board, on October 25th, and all meetings thereafter, shall be open to the public. The meetings will be held at 841 Fulton street.

Prescott, Ariz.—A survey for an electric road to connect Hassayampa district with Prescott was recently made by the Prescott & Mount Union Railway engineers, and a preliminary survey for a narrow gauge railroad connecting it with the terminus of the Poland branch of the Bradshaw Mountain Railroad through the Poland tunnel has also been made, and there are good prospects for the construction work on perhaps both of these lines to commence at an early date.

San Francisco, Cal.—The United Railroads has placed an order for 500 new searchlights with a New York firm. The lights will be of the latest pattern and will be able to throw a path of light about 2,000 feet, so that objects can be plainly discerned at that distance. The old lights now in use will be discarded and the new ones will be placed on all the cars.

Palo Alto, Cal.—Mrs. W. H. H. Hart, wife of the attorney, seeks by injunction to prevent the laying of the tracks along Emerson street and Hawthorne avenue by the Hanchett Street Railway Co. under authority of the permit given it by the Board of Trustees. Mrs. Hart today applied to the Superior Court of Santa Clara county for an injunction to restrain the company from proceeding with the work already begun. Mrs. Hart owns a block of land immediately across the street from the lots that the president of the Board of Town Trustees, J. F. Parkinson, sold to the Hanchett Co. for its barn site. The complaint alleges that the permit is void because it is in effect a franchise passed in violation of the law at the meeting at which it was introduced and without advertisement for bids.

Vallejo, Cal.—Melville Dozier has been granted a franchise to build an electric railroad through this county. Dozier states that he will commence building his road in four months' time and will have it completed in about two years. This road will be a rival of the San Francisco, Vallejo & Vaca Valley road, which is promoted by Col. J. W. Hartzell of this city.

Pomona, Cal.—Notice is given that application has been made to the Board of Trustees of the city for a franchise granting the right to construct an electric railroad upon certain streets. Sealed bids will be received for the franchise up to November 6, 1906.

Bisbee, Ariz.—Word has been received at the Bakerville office of the Warren Realty & Development Co. from the Duluth offices of the concern that plans and specifications for development of the new town of Warren have been approved and instructions received to proceed with the opening of the new town. The town of Warren is to be connected with Bisbee by an electric trolley line, work on which has just begun. Work on a water plant and system and an electric lighting plant will be commenced in the near future. The entire work is under the supervision of Col. Cleve W. Van Dyke, and a large corps of engineers and architects are at work.

Dayton, Wash.—The council granted a franchise to the Columbia & Walla Walla Traction Co.

North Yakima, Wash.—An ordinance granting the Intervalley Traction Co. the right to build and operate a system of street cars upon certain streets within the city limits was passed over the mayor's veto at a recent meeting of the City Council.

Sunnyside, Wash.—The council granted a franchise to R. G. Ry and S. J. Harrison to construct and operate a railway system in the city limits.

Walla Walla, Wash.—The council granted a franchise to the Columbia & Walla Walla Valley Traction Co. to use certain streets of the city.

WATERWORKS.

City of Mexico.—A general meeting of the land owners of the St. Andrew's Colony, S. L. C., will be held to provide for the sale of sufficient bonds to cover authorized improvements. The committee has secured a concession from the Board of Public Works for sewerage and for construction of waterworks.

Oakland, Cal.—The City Council has appropriated $27,000 for a salt water plant.

Crystal Springs, Nev.—A survey is being made for the pipe line from the Lynch ranch on the Amargosa to the property of the Bullfrog Co. A pumping station will be established on the Crystal Springs town site.

Monrovia, Cal.—The report of Engineer O. K. Parker regarding the city water system improvements, which recommends an expenditure of from $80,000 to $100,000, has not been acted upon by the board. Bonds will have to be issued to cover the cost. The overhauling and remodeling of the city water system is imperative.

Bullfrog, Nev.—The Montgomery-Shoshone Extension mine, which is located on Montgomery mountain, has improvements under consideration which include a water pipe line.

Chico, Cal.—When the council opened bids for a city pump there were found to be three submitted by a San Francisco firm. These were referred to the engineer and sewer committee.

Los Angeles, Cal.—The Board of Commissioners has authorized the closing of certain options on the Owens Valley property to protect the city's water rights and ordered advertisements for bids on the lease of ranch lands in the valley. It is proposed that the city put up a cement plant and manufacture the cement required in the construction of the Owens river conduit. The Board of Engineers will probably hold its first meeting in the city November 12th. A reservoir site in Swartout canyon has been located.

Tacoma, Wash.—The water committee will recommend to the council that resolutions be adopted authorizing the engineer to superintend the overhauling of the South Tacoma well system, put down additional wells to furnish a sufficient supply of water, and to build a 30-inch stave pipe to replace the flume between South Tacoma and Station B. Estimated cost, $45,000.

Billings, Mont.—It is reported that a municipal water system will be constructed to cost about $400,000. One mile of 18-inch pipe and 3½ miles of 20-inch pipe will be needed; also a pump of 3,500 gallons capacity a minute, one pair horizontal 500 horsepower 42-inch turbines, concrete head gates and power house. Henry Gerbarz, city engineer.

Walla Walla, Wash.—The Gilbert Hunt Co. was awarded a contract to furnish 100 fire hydrants for $2,547.50. Four firms bid on the contract.

OIL.

Coalinga, Cal.—The Union Oil Co. is producing all it can from the wells in the Santa Maria district, with the exception of wells on the Folsom Nos. 3, 4, 5, 6 and 7. Union Oil Co., Hill Camp, Lompoc District, wells Nos. 1 and 2, shut in; No. 3, abandoned; No. 4, pumping about 200 barrels per day. This company will commence to produce all it can the 1st of October and will pump to Orcutt station from Hill Camp and the Purisema lease. It is running one drilling outfit on the Eefson, at No. 4, and will commence work again soon on the Burton mesa.

San Francisco, Cal.—C. L. Arques, agent at Port Harford for the oil barge Sonoma, which took fire at a railroad wharf at Port Harford August 22d, claims in a report of the fire sent to Washington that representatives of the Standard Oil Co. tried to prevent his extinguishing the fire on the boat, claiming that they appeared on the wharf with pistols and rifles, cutting the boat loose and turning off the water supply with which he was fighting the fire. According to the report, the damage to the Sonoma amounted to only a few hundred dollars.

INCORPORATIONS.

San Francisco, Cal.—A new company, to be known as the Coast Oil Transport Co., has been formed for the purpose of constructing pipe lines for petroleum, gas and water, and telephone and telegraph lines in conjunction with them, in incorporation have been filed showing a capital stock of $1,000,000, with $5,000 subscribed. The incorporators are: Adolph Phillips of Arroyo Grande, C. H. Lamberton, Ben Santa Barbara and San Luis Obispo counties. Articles of Liebes, H. P. Cole and Maurice Casey, all of San Francisco. The proposed lines are described as being about 50 miles in length, commencing at a point near Harris Station on the line of the Pacific Coast Railway Co. in Santa Barbara county, and extending northwest to Port Harford on San Luis Obispo Bay, and westward to Casmalia on the line of the Southern Pacific in Santa Barbara county.

San Francisco, Cal.—The Oriental & Occidental Wireless Co. of Maine has filed a certified copy of articles of incorporation.

Los Angeles, Cal.—The Lindcove Water Co. has been incorporated here with a capital stock of $25,000, subscribed $250, by W. S .Fletcher, F. E. Robinson, I. L. Spencer, C. M. Smith and S. P. Fowler.

City of Mexico—A new company has been formed in San Pedro de las Colonias, Coahuila, for purpose of installing a street car system in that town. One of the members is now in the United States buying rolling stock, rails and other supplies. Work of grading and track laying will begin in a few days.

FINANCIAL.

Reno, Nev.—The fact has developed that the Nevada Transit Co., the property of Herbert Flushacker, Joseph Martin and J. A. Buck, was not included in the reported sale of the Reno Power, Light & Water Co. and the Truckee River General Electric Co. to Eastern capitalists, and that local people are negotiating for the purchase of the line. A price that will not be far from $150,000 may be the consideration. It is practically conceded that the sale of the Truckee River General Electric and Reno Power, Light & Water Co. has been closed.

San Francisco, Cal.—The General Electric Power Co. has filed a certificate of an increase of its bonded indebtedness from $7,500,000 to $9,000,000. The bonds draw interest at 5 per cent.

San Pedro, Cal.—At the last meeting of the board of the city of Wilmington the matter of constructing a city light and water plant through issuance of $200,000 or $300,000 worth of bonds was considered.

San Francisco, Cal.—An official circular has been issued by the board of directors of the Contra Costa Water Co. advising the stockholders that an agreement has been made to sell their stock, provided that at least 67 per cent of the total stock is offered to the People's Water Co. at $20 in cash and $50 in bonds per share. The Mercantile Trust Co. is to be trustee, and the shareholders must sign the proposed agreement by December 1, 1906.

San Francisco, Cal.—The Supreme Court has decided that the San Lorenzo Water Co. is not responsible for the destruction by fire of the canning plant of Hunt Bros. Co. at Haywards. The plant was burned April 12, 1901. Hunt Bros. collected $91,281.42 insurance and they sued the water company for $124,496.98 on the ground that the fire would have been put out had the water company fulfilled its contract to put in a service pipe and fire hydrant near the cannery. The insurance companies assigned their claims. The decision was in favor of the defendant in the lower court and was affirmed by the Supreme Court.

San Francisco, Cal.—The second installment of $5 per share on the purchase of the Mutual Electric Light Co. is being paid at the Mercantile Trust Co.'s office to those stockholders who did not sign the agreement.